DOCUMENT RESUME

ED 052 003	SE 010 156
TITLE	DISCUS Eighth Grade, Physical Sciences, Part 2.
INSTITUTION	Duval County School Board, Jacksonville, Fla. Project DISCUS.
PUB DATE	[69]
NOTE	132p.
EDRS PRICE	EDRS Price MF-$0.65 HC Not Available from EDRS.
DESCRIPTORS	*Disadvantaged Youth, *Instructional Materials, Laboratory Procedures, *Physical Sciences, Science Activities, *Secondary School Science, *Teaching Guides

ABSTRACT

Included are instructional materials designed for use with disadvantaged students who have a limited reading ability and poor command of English. The guide is the second volume of a two volume, one year program in physical science, and contains these four units and activities: Buoyancy, nine activities; Solubility, six activities; Crystals and Crystal Growing, seven activities; and Using Electricity, eight activities. A formal textbook is not used in this program, and the learning process relies on class discussion supported by audiovisual materials and small group laboratory activities. Each lesson has a suggested format for teachers to follow in directing activities, with suggested teacher comments. Following each teacher section is the printed material for student use, which generally has a list of required equipment for small group activities, introduction and procedures, and fill-in questions relating to the completed activity. One or more full page diagrams for making transparencies for overhead projection are included for most of the activities. (PR)

ED052003

DISCUS EIGHTH GRADE PHYSICAL SCIENCE

TABLE OF CONTENTS

UNIT 6 BUOYANCY

The purpose of this unit is to increase the students' awareness and to some extent their quantitative perception of the buoyant force of water. An underlying purpose of this and the following units is to reflect the properties of water and the usefulness of water as a standard of reference.

The activities included in Unit 6 are:

P - 29 FEELING BUOYANCY

P - 30 SEEING BUOYANCY

*P - 31 EUREKA

P - 32 IT SINKS

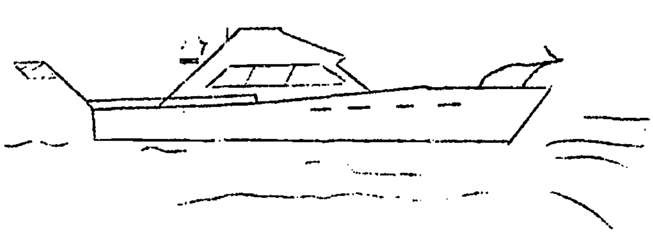
P - 33 FLOATING AND SINKING

*P - 34 SWIMMING IN THE OCEAN, ANTIFREEZE, ETC.

P - 35 NAVIGATION

P - 36 SUNKEN TREASURE

P - 37 THE BAHAMAS

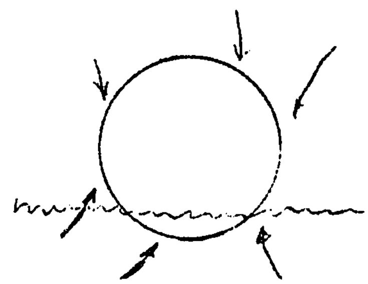


TEACHER RESOURCE

Buoyancy is the upward force that a liquid exerts on an object placed in a liquid (usually water). This force can be observed (a boat floats) as well as felt (pushing a cork under water). Buoyancy opposes gravity and, if the object floats. overcomes the force of gravity.

A beach ball floats . . . . . .

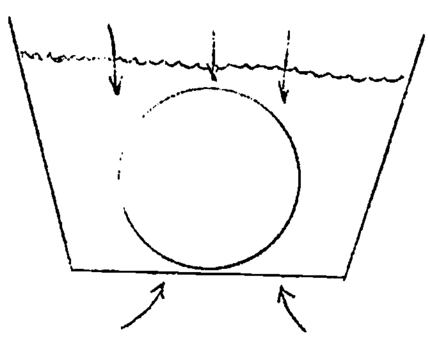
IF the byoyant force is greater than the force of gravity



But all objects do not float--some sink. Nevertheless, the liquid exerts a buoyant force on these objects. Objects such as a submarine can be "floated" at various depths and objects appear to weigh less when submerged in water.

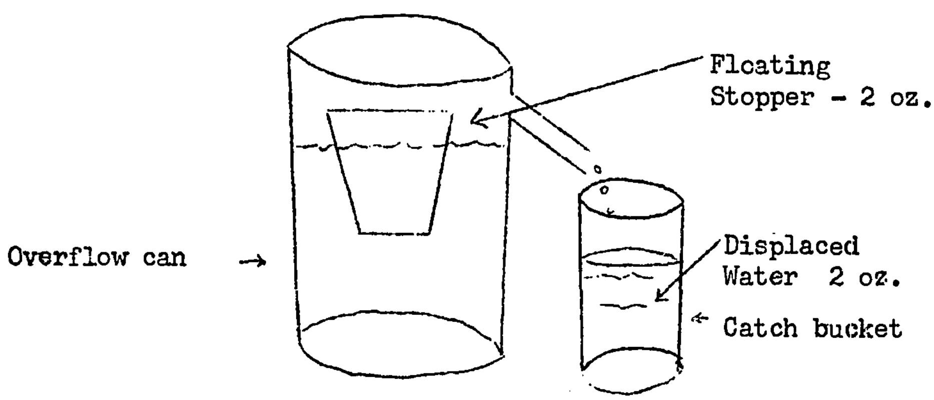
A metal ball sinks . . . . .

IF the buoyant force is less than the force of gravity

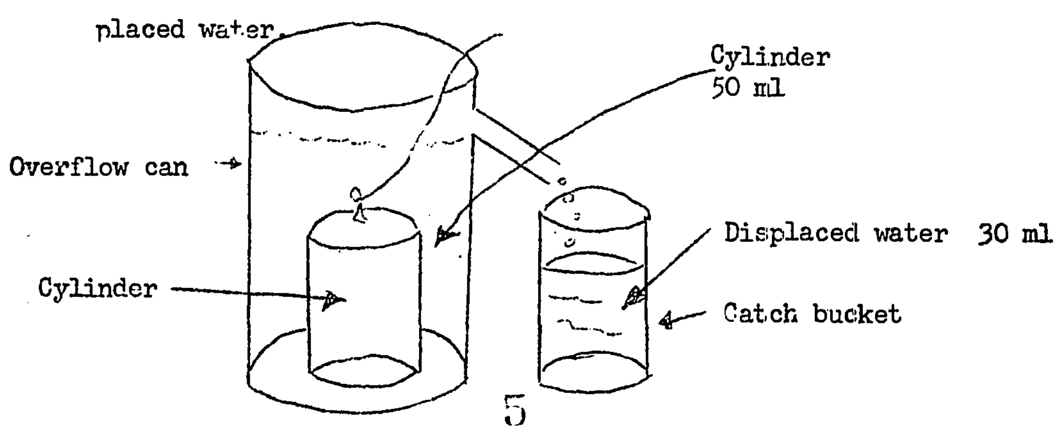


As an object sinks into the water, it must displace a certain amount of the water, for both the object and the water cannot occupy the same space at the same time. The amount of water displaced or pushed aside is a direct measurement of the buoyant force the water exerts on the object.

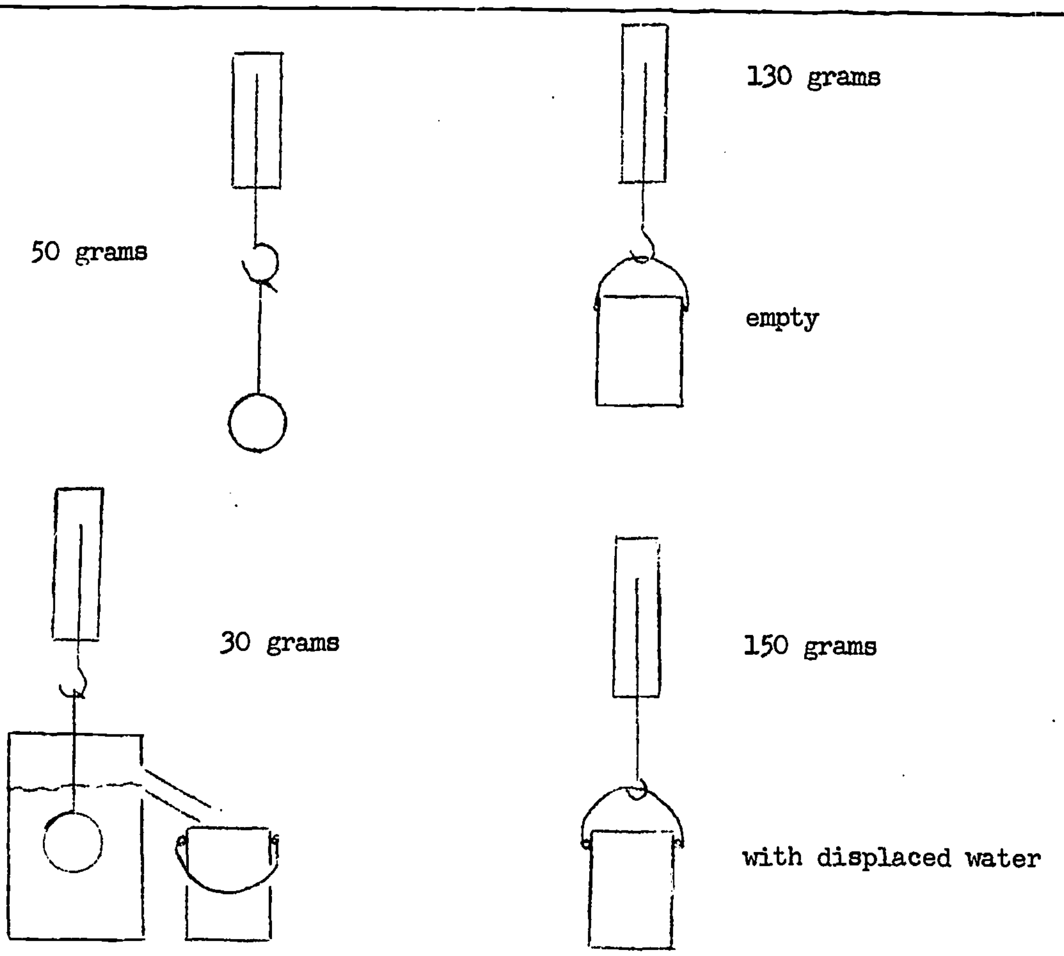
1. If an object, when placed in water, floats, then the amount (weight) of the water displaced is equal to the weight of the object. The volume of water displaced will be equal to the volume of the object which is actually under water.



2. If an object, when placed in water, does not float, then the amount (volume) of the water displaced is equal to the volume of the object. The weight of the object is greater than the weight of the displaced water. The apparent loss of weight of the object, when submerged, is equal to the weight of the displaced water.



3. Archimedes' principle states that an immersed object is pushed or buoyed up by a force equal to the weight of the water which the object displaces.



weight of ball in air	50 g.	weight of empty bucket	130 g.
weight of ball in water	30 g.	weight of bucket and water	150 g.
difference in weight	20 g.	difference in weight	20 g.

In summary, objects immersed in water have exerted on them a buoyant force. The objects are either partially or totally supported by this buoyant force. When the buoyant force is less than the object's weight, the object sinks. When the buoyant force is greater than the object's weight, the object floats.

Topic 1 - Buoyancy is a force exerted by water on an object.

The first two activities will introduce the students to buoyancy by letting them feel the effects of buoyancy and by showing the effect of shape on displacement. The next three activities are quantitative determinations verifying Archimedes' principle.

HOW MANY OF YOU CAN SWIM? HOW MANY OF YOU CAN FLOAT? HOW MUCH DO YOU WEIGH IN WATER? (Almost nothing, apparently, actually no change.) IF YOU THREW A BRICK INTO THE RIVER, WOULD YOU EXPECT IT TO FLOAT? (No.) WOULD A BOARD FLOAT? (Maybe.) SOME BOATS HAVE A MATERIAL UNDER THE SEATS AND OTHER PLACES WHICH WILL INCREASE THE FLOTATION, OR KEEP THE BOAT FROM SINKING IF IT TURNS OVER OR FILLS UP WITH WATER. WHAT IS THIS MATERIAL? (Styrofoam, cork, kapok.) HOW DOES IT WORK? Some may reply that trapped air causes the flotation, but this adds only a small part. The difference in density between the water and the material used gives the major effect. We will investigate density in a later activity, so do not emphasize the concept at this time. IF A BRICK WEIGHS ABOUT 5 POUNDS, AND YOU CAN PICK UP 20 BRICKS, OR 100 POUNDS, HOW MANY BRICKS COULD YOU PICK UP IF BOTH YOU AND THE BRICKS WERE UNDER WATER? Discussion. WE CAN ONLY GUESS NOW, BUT KEEP THINKING ABOUT THE QUESTION, AND WE WILL FIND OUT WHAT THE ANSWER IS SOON. BUT FIRST, LET'S FIND OUT ABOUT BUOYANCY.

Pass out P - 29

TEACHER DIRECTION P - 29

FEELING BUOYANCY

Materials for groups of three:

1. Bucket
2. Brick
3. Wood (2" x 4" x 8")
4. Styrofoam (2" x 4" x 8")

Using transparency P - 29 instruct the students to add water to their bucket until it is half full. You may want to perform this and the next activity outside due to spills and excess water. The students are to slowly submerge the brick, wood, and the styrofoam in the water in an effort to feel the difference in weight if they hold the objects in the palm of their hand. Ask them to guess the weight of the objects in the palm of their hand. Ask them to guess the weight of the objects under water as well as out of the water. The brick will sink but should appear to be lighter under water. The wood block will float and will appear to weigh "almost nothing" under water. The styrofoam will float high in the water and will show "negative weight" when submerged. Encourage the students to try other objects.

A group discussion will be good if time permits. Use transparency P - 29 for the discussion.

STUDENT P - 29

FEELING BUOYANCY

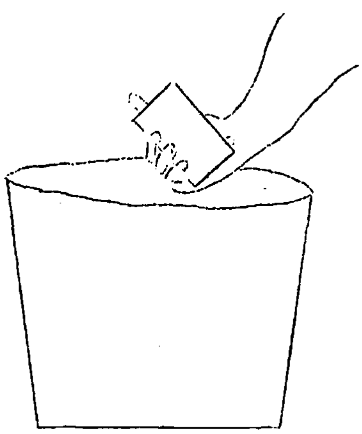
Materials for groups of three:

1. Bucket
2. Brick
3. Wood block
4. Styrofoam

Boats and some people float. Rocks and some people do not float but rather sink. What is the difference in boats and rocks? Why do boats float and rocks sink? Large ships are made out of steel, which is very heavy, and they float. They even carry a lot of cargo. Why does a ship float?

To answer these questions, we are going to make some comparisons. Let's compare the weight of a brick, a piece of wood, and styrofoam, both in and out of the water. Notice that they are all about the same size.

Take your bucket to a hose and add water to your bucket until it is half full. Hold each object and estimate or measure its weight. Then hold the objects under water and again estimate the weights. Record these estimates in the table on the next page. Everyone in the group should try to guess the right weights.



ESTIMATED WEIGHT

STUDENT	OBJECT	DRY WEIGHT	WET WEIGHT
1	BRICK		
	WOOD		
	STYROFOAM		

STUDENT	OBJECT	DRY WEIGHT	WET WEIGHT
2	BRICK		
	WOOD		
	STYROFOAM		

STUDENT	OBJECT	DRY WEIGHT	WET WEIGHT
3	BRICK		
	WOOD		
	STYROFOAM		

Which object was heaviest? ______________________

Which object was lightest? ______________________

How many bricks could you pick up if you and the bricks were under water?

TEACHER DIRECTION P - 30

SEEING BUOYANCY

Materials for groups of three:

1. Bucket
2. Aluminum foil (24" x 12")
3. Gas collecting bottle
4. Medicine dropper
5. Rubber stopper

You will probably want to conduct this activity outside since it involves large quantities of water. Each group will need to half fill their bucket with water. Then construct a boat out of the foil and float it on the water. Then construct a smaller boat by reshaping the foil, such as folding it in half, but do not dispose of any of the foil. Construct several boats, each smaller than the one before. If the boats do not sink toward the end. instruct the students to "wad up" the foil and see if it will still float.

The students should begin to realize that the relation of weight to volume determines wheather an object floats or not.

Add water to the gas bottle until two-thirds full. Then add water to the medicine dropper adjusting the amount so that the dropper just barely floats. Let the medicine dropper represent a submarine or a cartesian diver. Put the dropper in the bottle and stopper the bottle. Applying pressure to the stopper compresses the air in the bottle and the dropper causing the medicine dropper to sink. Releasing the pressure on the stopper allow the medicine dropper to float again.

Pass out P - 30

STUDENT

P - 30

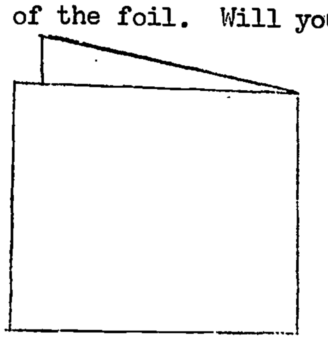
SEEING BUOYANCY

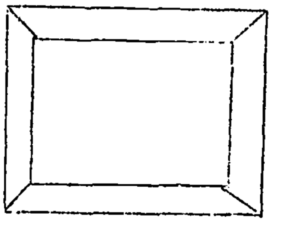
Materials for groups of three:

1. Bucket
2. Aluminum foil (12" x 24")
3. Gas collecting bottle
4. Medicine dropper
5. Rubber stopper

Buoyancy is what makes things float. You know that objects appear to weigh less in water than they do on dry land. But they only appear to weigh less because buoyancy is helping you hold up the object. Let's take a closer look at buoyancy and try to figure out just what it is.

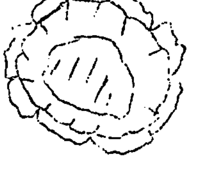
Add water to your bucket until it is almost full. Fold your foil so that it is square shaped. Make a boat out of the foil by turning up the edges of the foil. Will your boat float?





Fold the foil in half again and shape it into a boat. Will it float? Keep folding the foil in half and shaping it into a boat to see how small a boat you can make and still float.

Why did the last boat sink? Remember, the weight of the boat stayed the same. The only thing you changed was the size.

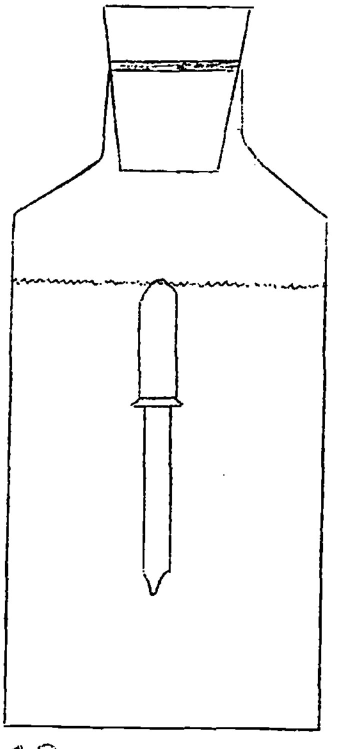


Student
page 2

Have you ever wondered how a submarine floats at different depths? Or why some logs float just under the surface of the water? When you swim under water, do you have trouble staying under?

Add water to your gas bottle until it is about three-fourths full. Then add water to your medicine dropper until it just barely floats. Put the medicine dropper in the gas bottle, stopper the bottle, and see what happend.

Push down on the stopper and see what happens to the medicine dropper. Take the stopper out of the bottle and see what happens. Do this several times and notice what happens to the water level in the medicine dropper.



Topic 2 - If an object floats in water the object will displace its own weight of water. If an object does not float in water, the object will displace its own volume of water.

Activity 31 is a reading activity about Archimedes. The next two activities will quantitatively show Archimedes principle and introduce density.

GOLD, SILVER, AND LEAD ARE VERY HEAVY METALS -- THAT IS, A SMALL AMOUNT WEIGHS A LOT. GOLD WEIGHS ABOUT 19 TIMES AS MUCH AS WATER. ONE GALLON OF WATER WEIGHS SEVEN AND ONE-HALF POUNDS. HOW MUCH WOULD A GALLON OF GOLD WEIGH? Discussion. (use a transparency to multiply $19 \times 7\frac{1}{2} = 142\frac{1}{2}$ pounds) GOLD IS WORTH $35.00 AN OUNCE. THAT MEANS THAT A GALLON OF GOLD WOULD BE WORTH --- LET'S SEE. Discussion. ($142\frac{1}{2}$ pounds x 16 ounces per pound = 2,280 ounces in a gallon of gold. 2,280 ounces x $35.00 per ounce = $79,800.00, the cost of one gallon of gold.)

THIS IS PRETTY EXPENSIVE STUFF. IF YOU WERE BUYING A GOLD RING, HOW COULD YOU TELL IF IT WERE REAL GOLD. IT MAY BE JUST LEAD COVERED WITH A THIN LAYER OF GOLD. HOW COULD YOU TELL? Discussion (After several have offered solutions, mention Archimedes) THIS VERY QUESTION, "IS THIS REAL GOLD?" LED TO A VERY IMPORTANT DISCOVERY MANY YEARS AGO. LET'S READ ABOUT IT.

Pass out P - 31

TEACHER DIRECTION

P - 31

EUREKA

This is a reading activity about Archimedes and his efforts to determine the purity of the gold in King Hiero's crown. The primary purpose of the activity is to introduce density and lead into a quantitative verification of Archimedes Law.

You will need to pronounce Archimedes and Eureka for the students and you will possibly need to read the activity to the class.

After reading the activity, discuss the conclusions and plans for the next two activities.

King Kiero and the scientist Hero are different men.

STUDENT P - 31

EUREKA

Have you ever wondered when the wheel was made, or the first time a lever was used. The inclined plane was used in building the Pyramids. The wheel was also used by the Egyptians in building the Pyramids. But we don't really know when these machines were first used.

Several years ago — about 2,000 years - there lived in Syracuse, Greece, a sharp fellow named Archimedes. Archimedes made his living as an engineer and was one of the first men to use machines in everyday jobs. He used levers and pulleys to help him in his work at the shipyards. You see, they had to put ships in dry dock to repair them just as we do today.

But Archimedes is probably better known for his work with buoyancy than anthing else. After reading his story, you will see how discoveries are made.

Hiero was king of Syracuse, Greece, during Archimedes' time. And if you remember, king's could be cruel and sneaky and demanded much from their subjects. Well, King Hiero decided that he needed a new crown made of pure gold. He ordered one made and, when it arrived, he began to wonder if it was <u>really</u> made out of pure gold. You know how sneaky people are — they think everybody else is sneaky, too.

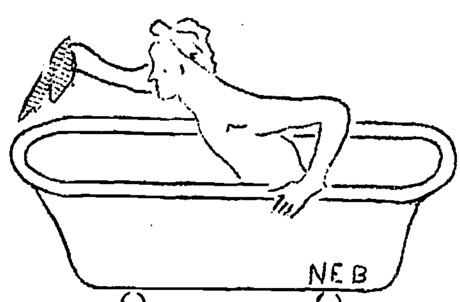
Archimedes had made the headlines several times and was looked upon as a pretty smart scientist. So, the king called in Archimedes and asked him to find out if the crown was pure gold. Of course, he couldn't destroy or bend the crown; he had to find another way to check it out. You can imagine his problem, for in that day you couldn't say "no" or "I can't" to the king.

Student
page 2

Archimedes did a lot of thinking, and tried a lot of experiments, but none seemed to work. Then one day the solution just "popped out" while he was taking a bath. Have you ever noticed that the water level rises in the bathtub when you sit down in the water? How much higher it is? Well, Archimedes saw the solution and got so excited, he got dressed and ran down the street yelling "Eureka" which is a Greek word meaning " I have found it". I often wondered if he was happy because of the scientific discovery or because he had saved his neck. By the way, the crown was <u>not</u> pure gold and the goldsmith lost his head over the matter. How did Archimedes found out if the crown was pure gold? Tune in to the next activity.

P.S. Bring your own gold.

"The steady, silent work of the head and hands of people engaged in invention and industry has done more to shape the course of history than all the array of armies with bugle and sword."



TEACHER DIRECTION P - 32

IT SINKS

Materials for groups of three:

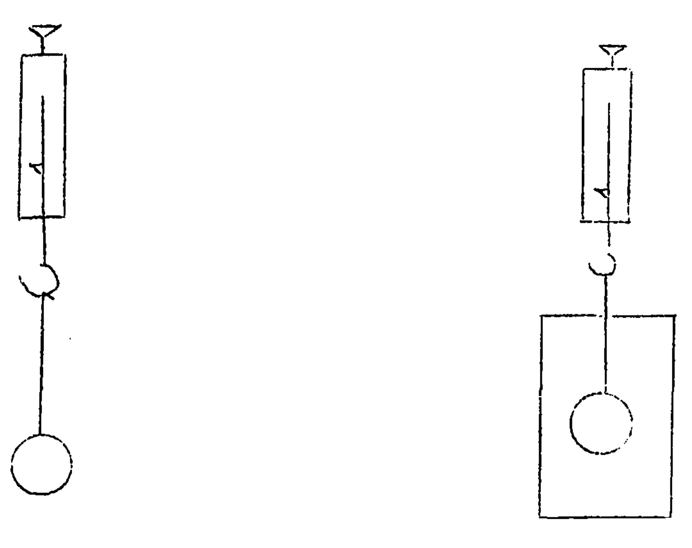
1. Bucket
2. Metal block
3. Spring balance
4. String (6 inches)

Archimedes law can be demonstrated by using a metal block in the place of the gold crown and weighing it both in water and in air. Several types of metals should be available, preferably a light, medium, and heavy metal.

Instruct the students to weigh the block while it is dry and again while it is submerged in water. Caution them against getting the spring balance wet. You will probably have to help some with their math.

Transparency P-32 will show the students the procedure and transparency P-32A lists some densities (which the students are actually calculating) which can be used to identify their metal.

The spring balances may be a source of error if they give poor readings. Pass out P-32



STUDENT

P - 32

IT SINKS

Materials for groups of three:

1. Bucket
2. Metal block
3. Spring balance
4. String (6 inches)

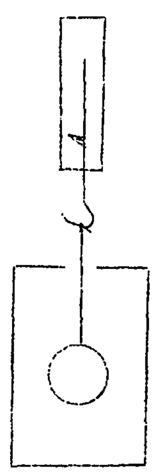
Archimedes found out how to show that the king's crown was not pure gold and saved his life. Let's find out how he actually did it. Who knows, it may save your life some day. It's really not hard to do.

You are going to have to find out two things before you can identify the metal. First, you need to know the weight of the metal. So, weigh the metal with your spring balance.

Next, you need to know how much the metal weighs under water. So, submerge your metal block in water being careful not to get the spring balance wet. How much does it weigh now? You are measuring the buoyant force or buoyancy of the water on the metal. Will it be the same for all metals? Of course not!

Record your data for all three metals in the table on the next page. After you have calculated "D", try to identify your metal by comparing your "D" with the values on the transparency.

Weight of metal in air ____________



Weight of metal in water ____________

Student
page 2

Metal	Weight in Air	Weight in Water	D
1			
2			
3			

$$D = \frac{\text{Weight of metal in air}}{\text{Weight in air - weight in water}} = \frac{\text{Weight}}{\text{Volume}}$$

Topic 3 - A less dense substance will float on a more dense substance.

Density can be changed by dissolving some material in the liquid.

HOW MANY OF YOU HAD EGGS FOR BREAKFAST THIS MORNING? Pause. DOES AN EGG FLOAT IN WATER? (Discussion) IS IT EASIER TO SWIM IN THE OCEAN THAN IN THE RIVER? (Discussion) yes. WHY? The students may guess that the salt in the ocean increases buoyancy, but don't tell them definitely yet. HOW DOES THE SERVICE STATION MAN CHECK YOUR BATTERY TO SEE IF IT IS ANY GOOD? Uses a hydrometer or floating tube which indicates the density of the acid in the battery. A charged battery will have a higher density than a low or discharged battery. Emphasize the point that the tube floats in the acid. LET'S FIND OUT IF AN EGG WILL FLOAT OR SINK. WHILE WE'RE AT IT, LET'S FIND OUT HOW TO CHECK OUR BATTERY.

Pass out P-33

TEACHER DIRECTION P - 33

FLOATING AND SINKING

Materials for groups of three:

1. Fresh egg
2. Two beakers, 250 ml
3. Table salt, 3 teaspoons
4. Grease pencil
5. Plastic soda straw
6. Modeling clay
7. Lead shot, 10
8. Graduated cylinder

Materials for instructor demonstration:

1. Graduated cylinder
2. Mercury (20 ml)
3. Carbon tetrachloride (20 ml)
4. Water (20 ml)
5. Kerosene (20 ml)
6. Steel ball ($\frac{1}{2}$ inch diameter)
7. Coal, $\frac{1}{2}$ inch lump
8. Paraffin ($\frac{1}{2}$ inch cube)
9. Cork ($\frac{1}{2}$ inch cube)

Instruct the students to handle the egg carefully — it will break. In making the hydrometer, be careful not to break the straw when slowly pushing it into the patty of clay. The clay should remain inside the straw acting as a stopper and adding weight. The clay on the outside of the straw should be removed and collected as you circulate among the groups. If a mistake is made in marking the straw with the grease pencil, the mark can be removed by wiping gently with a paper or cloth towel. Urge the students to do their experiments quickly so there will be enough time to discuss their results. After returning the materials to the proper places, reassemble for class discussion.

WILL AN EGG FLOAT IN WATER? (discussion) YOU HAD THE SAME AMOUNT OF WATER IN BOTH BEAKERS, DIDN'T YOU? (yes) THEY PROBABLY WEIGHED THE SAME BEFORE YOU PUT THE SALT IN THE SECOND BEAKER. Place a transparency on the overhead projector showing a beaker of drinking water and adding salt to a second beaker. WHAT HAPPENED TO THE WEIGHT OF THE BEAKER OF WATER WHEN

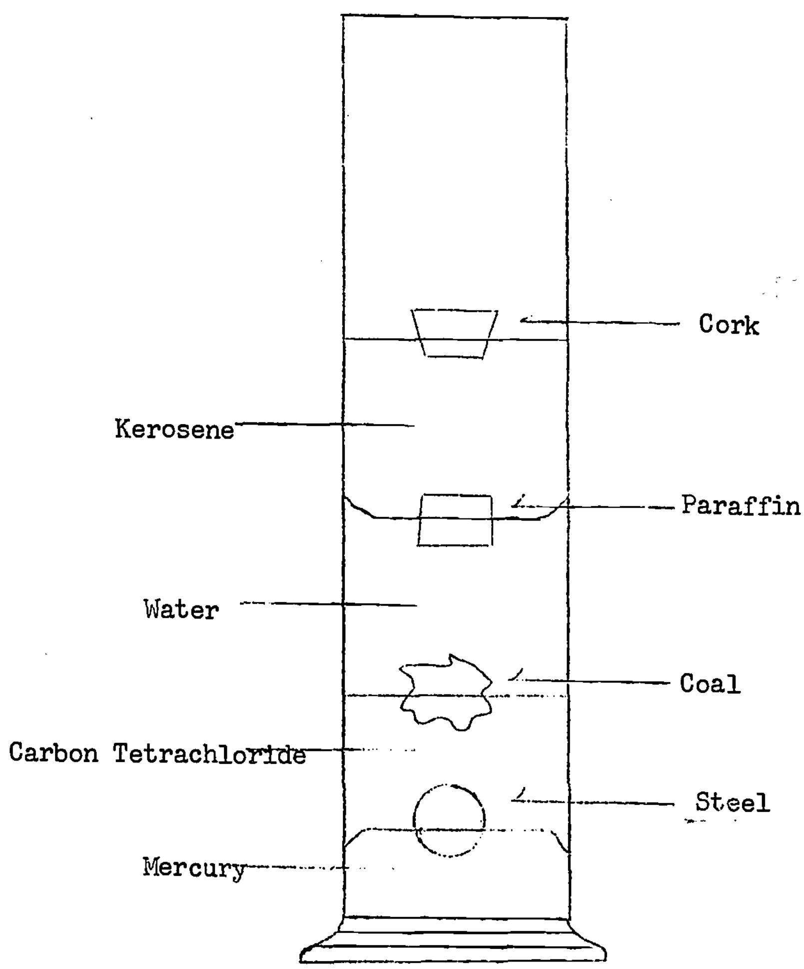
YOU ADDED THE SALT? Increased. DID THE VOLUME INCREASE, very little. THEN THE SALT WATER WEIGHS MORE THAN THE PURE WATER, DOESN'T IT? yes. THE SALT WATER IS MORE DENSE, OR HEAVIER, AND THE EGG FLOATED. THE SODA STRAW ALSO FLOATED HIGHER. HOW COULD WE USE A STRAW TO MEASURE THE DENSITY OF A LIQUID? Discussion.

TEACHER DEMONSTRATION

DO YOU BELIEVE THAT A SOLID STEEL BALL WILL FLOAT? Discussion. LET'S SEE. Gently roll a steel ball down the inside of a graduated cylinder. Lean the cylinder so that the ball rolls slowly. Then gently pour 20 ml of mercury down the side of the cylinder. The steel ball will float on the mercury. YES! A STEEL BALL WILL FLOAT, pause, ON MERCURY. MERCURY IS A VERY HEAVY LIQUID. IS MERCURY LESS DENSE OR MORE DENSE THAN IRON? Discussion. Place transparency P-33 on the overhead projector showing the density of mercury and iron with spaces for the other substances. THE DENSITY OF MERCURY IS 13.6 AND THE DENSITY OF IRON IS 7.5. SINCE IRON IS LIGHTER, IT WILL FLOAT IN MERCURY. Discussion. Explain that mercury is 13.6 times heavier than water and that iron is 7.5 times heavier than water (water has a density of 1). A GALLON OF WATER WEIGHS $7\frac{1}{2}$ POUNDS, THEREFORE, A GALLON OF MERCURY WOULD WEIGH 102 POUNDS ($7\frac{1}{2}$ times 13.6 = 102).

Teacher Demonstration
page 2

Continue the demonstration by carefully adding carbon tetrachloride (20 ml), coal (bituminous is prefered, anthracite will work) which will float on the carbon tetrachloride, water (20 ml) with a little ink or coloring, paraffin, kerosene, and finally the cork. Write in the densities of each on the transparencies as they are added. Point out that the less dense substances are nearer the top.



STUDENT

P - 33

FLOATING AND SINKING

Materials for groups of three:

1. Eggs (fresh), 2
2. Beaker (250 ml), 2
3. Table salt (NaCl)
4. Grease marking pencil
5. Plastic drinking straw
6. Clay
7. 10 lead shot
8. Graduated cylinder

When will a rock sink in a liquid? When will fresh eggs float in water? The answers can be found in this activity.

Add 150 ml water to each of two beakers. Number the beakers 1 and 2.

Form a patty of clay one-half inch thick. Stick one end of the straw into the clay. This will stop up one end. Then place the stopped-up end of the straw in the beaker of water and drop lead shots down in the straw until it stands straight up, but is still floating. Using a grease pencil put a mark on the straw at water level. Test the water level mark to make sure it is the same in both beakers of water. After testing the water mark, set the straw aside being careful not to spill any shot.

Place an egg in the first beaker of water. The egg should sink. Does it?

To beaker number 2 add about 3 teaspoons full of salt and stir well.

After adding the salt, use your straw to find out if the water mark is still the same for both beakers.

Student
page 2

Make a drawing on the two beakers showing the position of the egg and the weighted straw in (1) fresh water and (2) salt water.

1. Would it be easier to swim in the ocean than in fresh water?____________

2. Would a boat sink deeper in salt water than in fresh water?____________

It appears that things float higher in salt water than in fresh water.

TEACHER DIRECTION P - 34

SWIMMING IN THE OCEAN, ANTIFREEZE, ETC.

This is a reading activity designed to show more of the practical applications of density. The students will probably have questions and suggestions after reading the activity. This would be a good time for supplementing activities, doing library work, or repeating some activities.

SWIMMING IN THE OCEAN, ANTIFREEZE, ETC.

Can you swim? Can you float? Will an egg float in the ocean? Does the water in the ocean ever freeze? Can you boil ocean water?

Sure you can swim, and you can float. That is, you can swim and float in the ocean even if you can't swim and float in the river. What is the difference? You weigh the same in ocean water as you do in river water, so the difference must be in the water. Let's think about it.

You and Archimedes calculated a D value which was really the <u>density</u> of the metal. Density tells you how much heavier one object is than another. But remember, both objects must be the same size, such as a pint if you are to compare their densities.

What is the density of a person — of yourself? Well the density of water is 1. If you can float on water, your density is less than 1; and if you sink, your density is greater than 1.

DENSITY

FLOAT ⟵ ⟶ SINK

.24	.67	0.8	1.0	7.5	13.3	19.3
cork	gasoline	alcohol	water pure	iron	mercury	gold

But what about floating in salt water? Why does a fresh egg float in salt water and sink in fresh water? <u>Density</u>! Salt water is denser than fresh water and the more dense a liquid, the more it can support. Remember the steel ball floating on the mercury? Well, mercury is more dense than steel.

Student
page 2

LIQUID	DENSITY	SOLID	DENSITY
Gasoline	.70	Cork	.25
Alcohol	.80	Aluminium	2.7
Water	1.00	Iron	7.5
Glycerine	1.25	Silver	10.5
Mercury	13.6	Lead	11.5
		Gold	19.0
		Platinum	21.5

If the density of the liquid is greater than the density of the solid, the solid will float on the liquid. Liquids can even float on other liquids, such as oil or gasoline will float on water, and water will float on mercury.

Why do you add antifreeze to your car's radiator? How much do you add? How does the service station man check your radiator to see if it has enough antifreeze? Everyone knows that antifreeze keeps your water from freezing. Antifreeze will mix with water and, as you add more antifreeze, the solution becomes more dense. Antifreeze is denser than water. So, to check your antifreeze, you just check the density, This is the same way that you would check the water and acid solution in your battery.

Density is an important idea and you will find many places where you will need to use this idea.

TEACHER DIRECTION

P - 35

NAVIGATION

Materials for groups of three:

1. Cardboard (9" x 22") 2. Scissors 3. Compass

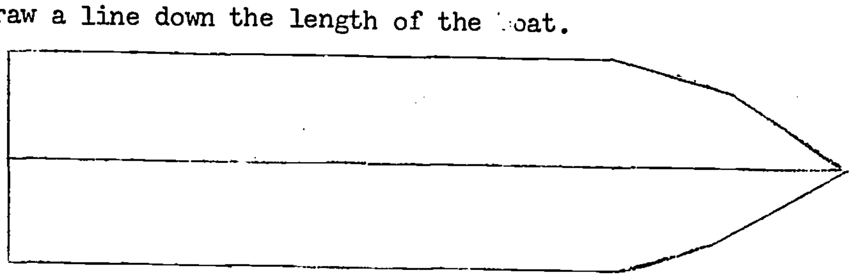
This activity is designed to teach the students the basic science of navigation and a few of the common terms of the sea. Boating is a rapidly growing sport for pleasure-seekers and also a growing service industry requiring more and more people to fill the new jobs. After this activity, the students should be acquainted with the function and use of the compass, the nautical mile, fathom, and the conversion of land measures to sea measures.

A marine compass probably will not be available, so the activities will be written for use with a standard land compass. The only change to be made if marine compasses are available is to simplify the procedures for staying on course.

HOW MANY OF YOU HAVE EVER BEEN FISHING? HOW MANY OF YOU HAVE EVER BEEN FISHING IN THE OCEAN? IF YOU CAN'T SEE ANYTHING BUT WATER, HOW DO YOU KNOW HOW TO GET BACK TO SHORE? Use a compass. WHAT IS A COMPASS? HOW DOES IT WORK? Use transparency P-35 to discuss the compass. Emphasize the degree markings.

LET'S TAKE A BOAT TRIP OUT IN THE OCEAN. OF COURSE, WE CAN'T REALLY GO OUT, BUT WE CAN PRACTICE OUR NAVIGATION. WE NEED A BOAT --- LET'S BUILD ONE.

Cut out a boat from a piece of cardboard (one for each group of three students) It should be large, about 18 to 24 inches long and 8 to 10 inches wide. Draw a line down the length of the boat.



Pass out P - 35

Teacher Direction
page 2

NOW WE HAVE A BOAT AND COMPASS, LET'S FIND OUT HOW TO NAVIGATE. PLACE YOUR COMPASS ON THE BOAT ON THE CENTER LINE. POINT YOUR BOAT NORTH. THIS WILL BE 0° AND ALSO 360°. NOW, SUPPOSE YOU WANTED TO TRAVEL ON A 60° BEARING. WHERE IS 60° ON THE COMPASS? Pause. TURN YOUR BOAT SO THAT YOU WOULD BE ON 60°. Pause. LET'S TRY IT THIS WAY. KEEPING THE COMPASS NEEDLE ON NORTH, TURN THE BOAT UNTIL THE CENTERLINE IS ON 60°. AS LONG AS WE KEEP THE NEEDLE ON NORTH, THE BOAT WILL POINT 60°, UNLESS WE ROTATE THE BOAT AGAIN. Pause, discussion.

After all seem to understand how to navigate, go outside to the "docks" and embark on a boat trip. They should end up at the "docks" if they follow directions. The directions will be given in nautical terms, so use the following conversion.

1 Nautical mile	=	1 step
1 Fathom	=	1 inch
1 Knot	=	1 step per second

Help each group get started on their first course, 135°, then let them go. After the "cruise" return to the classroom and plot the course on paper. One-half inch to the mile is a good scale.

For the next activity, bury a slip of paper four fathoms (inches) deep and plot a course using standardized steps and accurate measurements. The first group to find the paper gets a prize, perhaps a round of cokes. The last activity will also be a cruise.

STUDENT P - 35

NAVIGATION

Materials for groups of three:

1. Cardboard (9" x 22") 2. Scissors 3. Compass

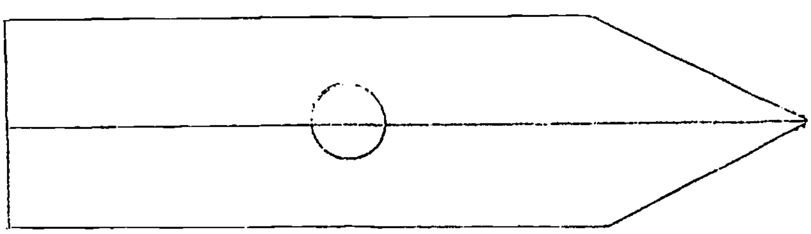
You have heard the word "navigation" many times. It really doesn't mean much to you beyond finding your way. The big question is HOW? In a car, you read signs and use a road map to direct you down the right road. But if you don't have a road map or a road or signs, what do you do? We pull a Daniel Boone and use a magnetic compass.

You all know what a compass is, just a magnet in a case. The magnet is pointed and the blue point always points north. If we know which way north is, then we know all the other directions, also.

Take your compass and look at the bottom of the case at the white card. Turn the case until the needle points North. Notice the other letters; turn the compass case and notice that the needle doesn't turn, it always points North.

You will be charting your course in degrees. The degrees scale is located around the outer edge of the compass case. Now, let's take a cruise.

Take a piece of cardboard and cut it out in the shape of a boat. Make it about 9" wide and 22" long



Draw a line down the center of the boat to use as a course line. Place your compass on the center of the boat and point it to the North. The N should be under the blue tip. Now, hold the compass still and rotate the boat until it points toward 135° (SE). The line on the boat should pass

Student
page 2

through 135° and 350°. As long as you hold the needle on 0° (N), the boat will point towards the 135° course.

1 nautical mile = 1 step

The course:

135° for 24 nautical miles (steps)
then 180° for 10 nautical miles
then 315° for 24 nautical miles
then 360° for 10 nautical miles

You should end up the same place you started. If not, try it again with another navigator. When you have finished, go back to your room and draw a chart of your cruise. Use a scale of $\frac{1}{2}$ inch equal 1 mile.

STUDENT P - 36

SUNKEN TREASURE

See if you can find the sunken treasure. Use your boat and compass to the exact spot and dig up the ....

Proceed on a course of 90° from the dock for 20 nautical miles. Ask your instructor for the exact length of the nautical mile (her step length). Turn to a course of 120° and sail 30 nautical miles. Turn to a course of 2[illegible]0° and proceed 30 miles. Now take a course of 300° and sail 20 miles. Then come about to 325° and proceed 10 miles. Send a diver down (dig) for about 4 fathoms (inches) and find the treasure. If you miss, start over.

STUDENT

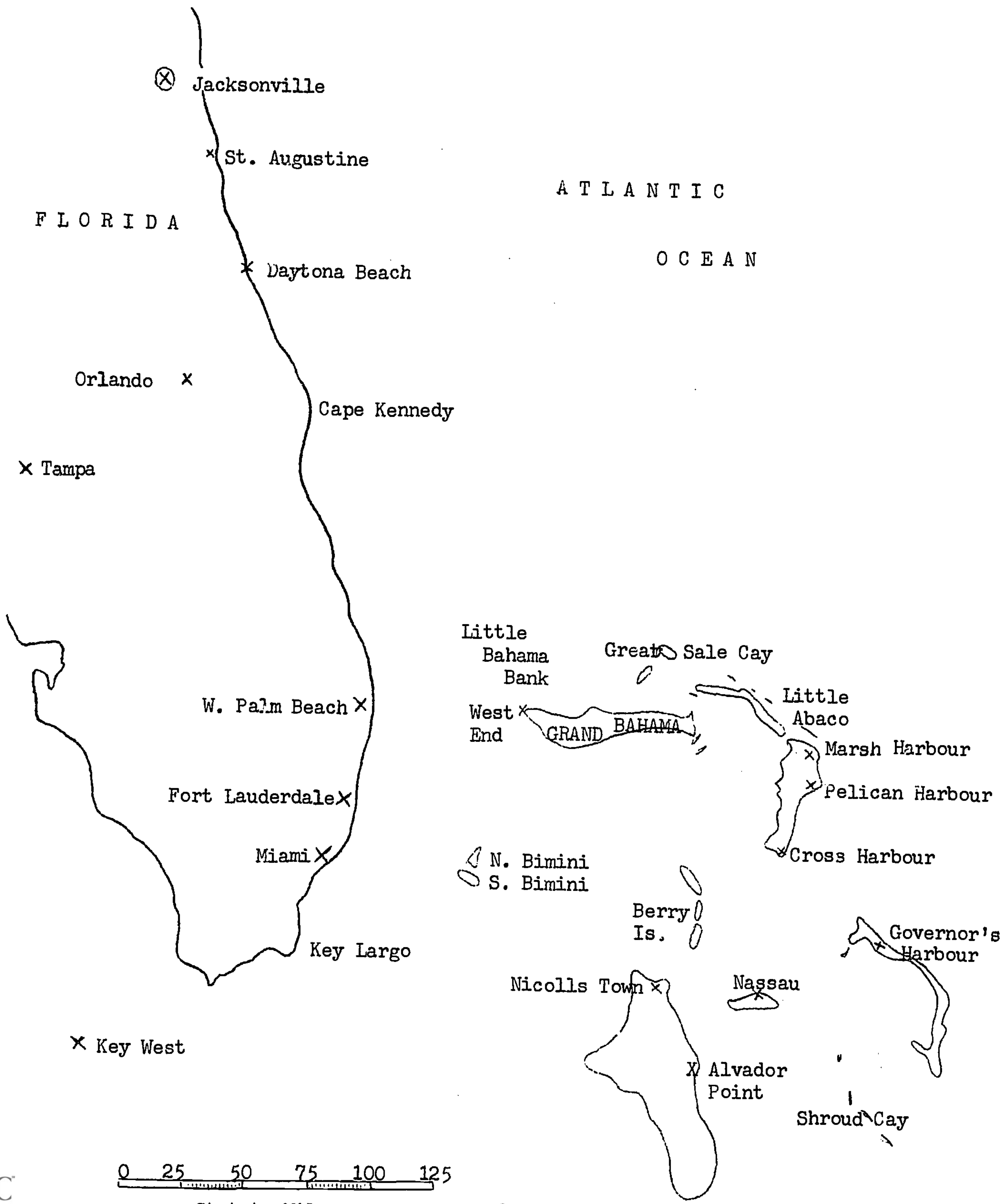
P - 37

THE BAHAMAS

You're probably a good navigator by now and you are ready to take a trip to the Bahama Islands. Some friends of yours might want to join you later, so they will need to know where you are. On the next page is a chart on which you can plot your course. Show your point of depature in Florida and draw a course to ten locations in the Bahamas. Also indicate where you will end up in Florida. Write on the chart the compass course headings for each leg of the journey and the distance. Use the scale.

Good sailing!

Student
page 2



UNIT 7 - SOLUBILITY

The purpose of this unit is to aquaint the students with some of the basic procedures needed to conduct laboratory investigations. The activities will introduce some new terms and laboratory equipment. This unit could be refered to as a "Kitchen chemistry" course for it is built around activities which can be done at home.

The activities included in this unit are:

*P-38	MEET SENOR' SOLUTION
P-39	BOILING SALT WATER
P-40	CAN YOU PASS THE TASTE TEST
P-41	FILL 'ER UP
P-42	A SUPER DUPER SOLUTION
P-43	CRYSTALS

TEACHER RESOURCE

The emphasis on vocabulary should be as limited as possible realizing that several new terms will need to be used rather frequently. Rely on this frequency of use for teaching.

A solution is an apparently clear and uniform substance that cannot be separated by filtration. The solution can be separated, however, by distillation. A mixture may or may not be a solution. If it is not a solution, then the parts of the mixture can be separated by settling or filtration. Sand and water will form a mixture, but sugar and water will form a solution.

The following terms will be used in the discussion.

Distillation - A process of heating a material and then condensing its vapors. This process is ordinarily used as a means of purification and separation of the ingredients of a mixture.

Filtrate - A liquid which has passed through a filter.

Filtration - The process of removing suspended particles from a mixture by allowing the fluid portion to pass through a porous material (filter paper).

Residue - Material left after the liquid is removed from a mixture.

Solute - The substance which is dissolved in a solvent to make a solution. Example: Salt is the main solute in sea water; sugar is the solute in syrup.

Solution - A uniform mixture, either clear or transparent, of some substance in water or other solvent.

Solvent - A substance (usually liquid) used to dissolve another substance. In sea water, water is the solvent.

Water will boil at approximately 100°C or 212°F. The addition of salt will raise the boiling point - the more salt, the higher the boiling point. It will lower the freezing point to an even greater degree.

A solution is saturated when it will not dissolve any more solute (materials, usually solid, being added). A saturated solution can be detected usually by the presence of crystals on the bottom of the container.

Teacher Resource
page 2

A solution can be super-saturated by forcing it to dissolve more crystals than it would under ordinary conditions. Since saturation depends to some extent on temperature, the usual procedure for super saturating a solution is to heat the solution, add more crystals, and cool slowly. Dust or solid particles of any kind (even a scratch on the container) will cause the solution to break down.

Topic 1 - A solution is a clear, uniform substance that cannot be separated into its component parts by filtration. It can be separated by distillation. A mixture can be separated by filtration.

PASS THE SYRUP, PLEASE. HOW IS SYRUP MADE? Discussion. YOU ADD SUGAR TO WATER, DON'T YOU. USUALLY YOU HEAT THE WATER TO GET THE SUGAR TO DISSOLVE FASTER. Pause. HOW DO YOU MAKE KETCHUP? Discussion. HOW CAN YOU TELL THE DIFFERENCE IN SYRUP AND KETCHUP. Discussion. IF KETCHUP AND SYRUP WERE THE SAME COLOR (if you added coloring to the syrup, for example), HOW COULD YOU TELL THE DIFFERENCE? Hold them up to the light and see if they are clear. You can see through the syrup, but you cannot see through the ketchup. THE SYRUP IS A SOLUTION (IT LETS LIGHT PASS THROUGH) AND THE KETCHUP IS A MIXTURE. CAN YOU THINK OF SOME EXAMPLES OF SOLUTIONS?

Examples of solutions:

Syrup (sugar and water)

Vinegar (acetic acid in water)

Sea water (various salts and other materials in water)

Vanilla extract (vanilla flavorings in alcohol)

Gasoline (various ingredients added to the pure fuel)

Kerosene (similar to gasoline)

Perfumes and colognes (alcohol usually as the solvent)

Colas and other soft drinks (Sugars, flavors, carbon dioxide in water)

Nail polish remover (ethyl acetate, ethyl butynate, acetone)

Air (Nitrogen, oxygen, carbon dioxide and other)

Carbonated water (carbon dioxide in water)

CAN YOU THINK OF SOME EXAMPLES OF MIXTURES?

Examples of mixtures which are not solutions:

Milk (Colloidal suspension some dissolved materials)

Ink

Oil in water (2 phases will not mix)

Mustard

Blood (complex mixtures - some dissolved materials)

Ketchup

Pass out P-38

TEACHER DIRECTION P - 38

MEET SENOR SOLUTION

This is a reading activity with an optional laboratory activity attached which can be done in class or at home.

Materials for groups of three:

1. Instant coffee (1 teaspoon)
2. Instant tea (1 teaspoon)
3. Instant Cocoa (1 teaspoon)
4. Copper sulfate (few crystals)

The students are to make colutions and/or mixtures and try to identify them as such. If this is assigned for home, you should let a student demonstrate a few of these to the class for discussion.

STUDENT P - 38

MEET SENOR SOLUTION

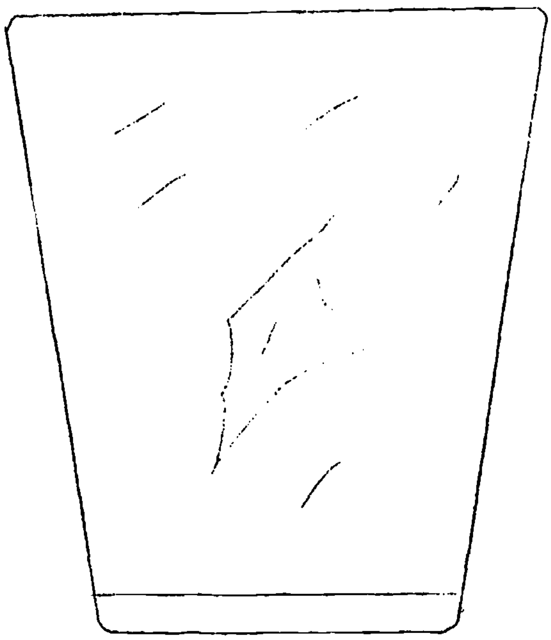
... and his big happy family!

You already know many of Senor Solution's family...they are the cokes and tea and coffee that we drink. Oh, do not forget that good cool cousin Lemonade! Just what makes Lemonade a member of the Solution family. Well to make lemonade we mix together lemon juice, water, and sugar. Now we mix these things together and stir them real good. Now we cannot see the sugar or the lemon juice or the water as they looked before we started making the lemonade. When we mix two or more things together so that we cannot tell just by looking at it what is mixed together, we call this mixture a solution.

Do you know any of Senor Solution's other relatives?

A glass of

TEA



A SOLUTION is

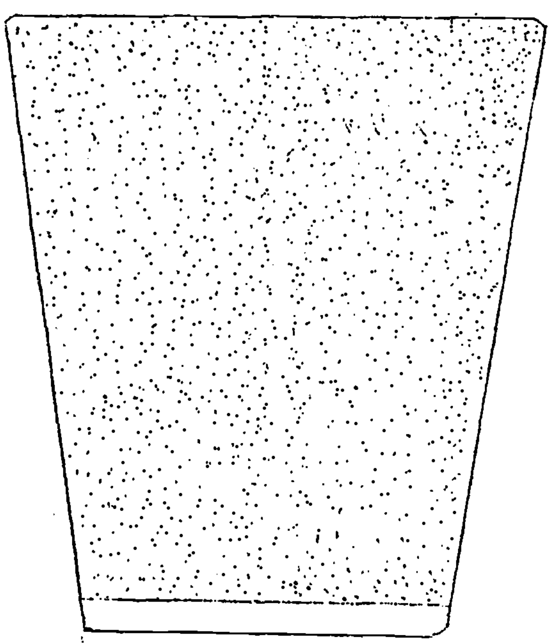
CLEAR

Student
page 2

The good Senor's family is not so happy because that wicked imposter, Mr. Mixture, has been seen in the neighborhood. He's up to his usual tricks telling everyone that he is one of the solutions. The careful eye can spot Mr. Mixture easily, though. Let me tell you how. Mr. Mixture is very disorganized and not at all clear. One part of Mr. Mixture may look completely different from another part.

The solution family is noted for their clear appearance. When you look at Simon Syrup you can't see one thing out of place. In fact, you can see right through him. Let's make a solution like Simon Syrup.

If we add a few teaspoonsful of sugar to a glass of water, we can make a solution by just stirring until all the particles of sugar are invisible. We say that they have been dissolved. The sugar water tates sweet, doesn't it? If we added a lot more sugar, maybe a couple of handfuls even, the solution will become very thick. This is how syrup is made.
Do you know any of Senor Solution's relatives?



STUDENT P - 38 A

SOLUTIONS AND MIXTURES

Materials needed for groups of three:

1. Instant coffee (1 teaspoon)
2. Instant tea (1 teaspoon)
3. Instant cocoa (1 teaspoon)
4. Copper Sulfate (few crystals)

Can you tell the difference in solutions and mixtures? Let's find out. All you have to remember is that:

1. Solutions are clear
2. Mixtures are cloudy

To a beaker of water, add one teaspoon of instant coffee (hot water is best).

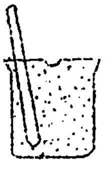
1. Does the coffee dissolve in the water?____________________
2. Is coffee a member of the solution family?________________

To a beaker of water, add one teaspoon of instant tea. (Hot water is best).

1. Does the tea dissolve in the water?____________________
2. Is tea a member of the solution family?________________

To a beaker of water, add a few crystals of copper sulfate. (Hot water is best).

1. What color is the solution?_______________
2. Is the solution clear?____________________

Stir  Briskly

TEACHER DIRECTION P - 39

BOILING SALT WATER

Materials for groups of three:

1. Alcohol burner
2. Flask (250 ml)
3. Rubber tubing (2 ft)
4. Pan for ice
5. Beaker (250 ml)
6. Salt (4 teaspoons)
7. Stirring rod
8. Measuring spoon
9. Ring stand and asbestos gauze
10. Graduated cylinder

Using the transparency and a set of apparatus, show the students how to set up for the activity. You will need to explain every step.

YESTERDAY WE TALKED ABOUT SOLUTIONS AND MIXTURES. YOU KNOW THAT A SOLUTION IS CLEAR AND THAT A MIXTURE IS NOT CLEAR. CAN A SOLUTION BE RED, OR GREEN, OR BLUE? yes. TODAY, LET'S MAKE A SOLUTION AND THEN UNMAKE THE SOLUTION. HERE'S HOW WE CAN DO IT.

TO A FLASK CONTAINING 100 ml OF WARM WATER, ADD FOUR TEASPOONS OF SALT. STIR THE MIXTURE UNTIL ALL THE SALT DISSOLVES. IS IT CLEAR? IT SHOULD BE BECAUSE WE SAID WE WERE GOING TO MAKE A SOLUTION. Discussion. NOW, TASTE THE SOLUTION. Discussion. YOU WILL WANT TO RECORD YOUR TASTE TEST ON THE DATA SHEET.

NOW, PLACE THE STOPPER CONTAINING A PIECE OF GLASS TUBING IN THE TOP OF THE FLASK. CAREFULLY PUT THE END OF THE RUBBER TUBING OVER THE GLASS TUBING. EXTEND THE RUBBER TUBING THROUGH THE PAN OF ICE AND INTO THE BEAKER.

LIGHT THE ALCOHOL BURNER AND HEAT THE SOLUTION. Discussion.

Pass out P - 39

STUDENT P - 39

BOILING SALT WATER

Materials for groups of three:

1. Alcohol burner
2. Flask (250 ml)
3. Rubber tubing (2 feet)
4. Pan for ice
5. Beaker (250 ml)
6. Salt (4 teaspoons)
7. Stirring rod
8. Measuring spoon
9. Ring stand and asbestos guage
10. Graduated cylinder

Let's see if you can make a solution and then let's see if you can unmake the solution, that is, separate it into its parts.

To a flask containing 100 ml of water, add 4 teaspoons of salt. Stir until the salt dissappears into the water. Is the solution clear?________ Where did the salt go?__________________. Is the water just as clear now as it was when we began our experiments?_____________

Taste the solution. What does it taste like?_____________. Place the stopper in the top of the flask and attach the rubber tubing to the glass tube in the stopper. Extend the tubing through the pan of ice and into the beaker.

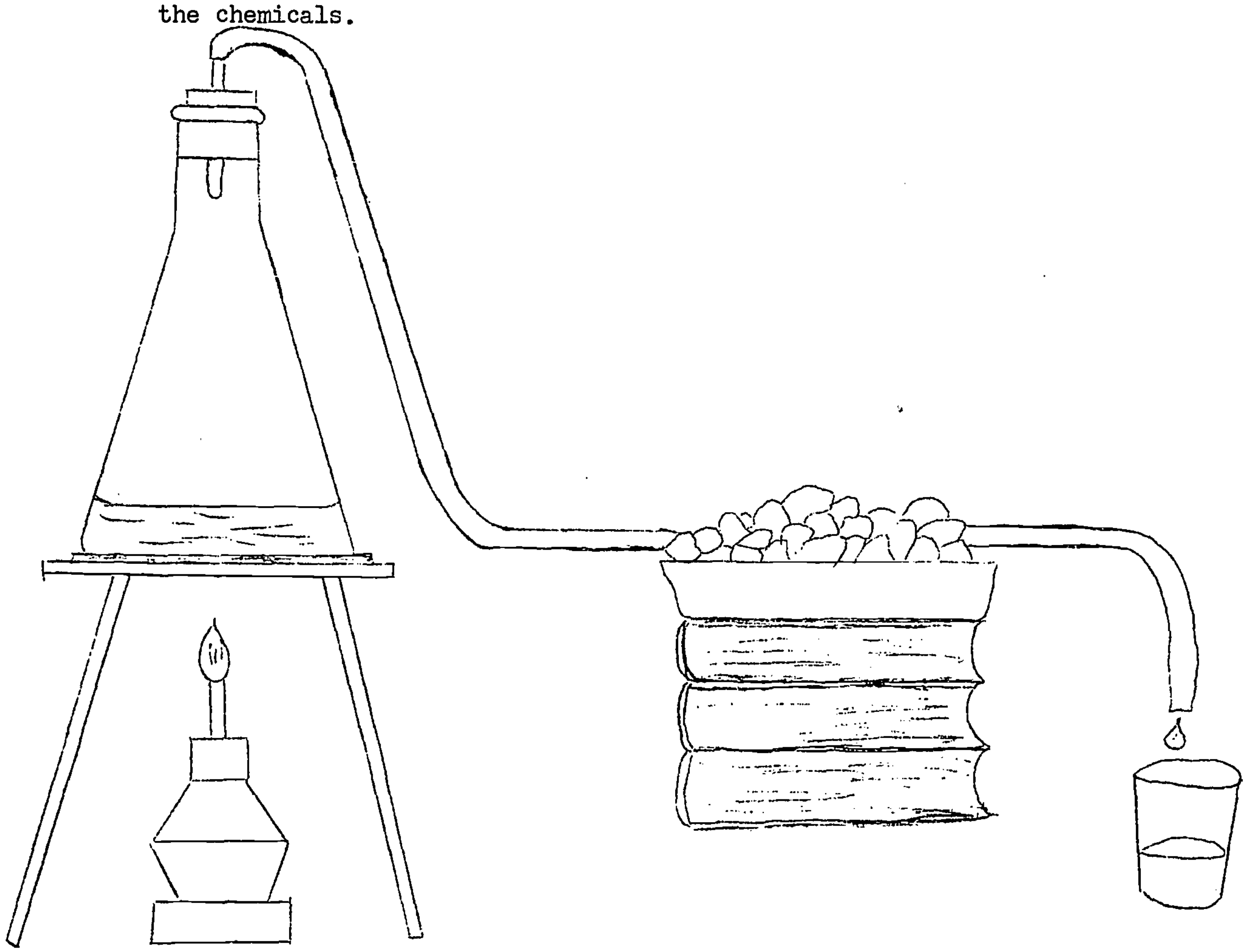
Light the burner and heat the solution. What happens to the solution. You are distilling the salt water.

Taste the hot water being collected in the beaker. Is it salty?______ Where is the salt you put in the water originally?___________ Cool the flask and taste the water. Is it salty?_____________

Sea water contains salt. If we can remove these salts from the water, it will be good to drink. In many places, this is exactly what people are doing. And they remove the salt using the same process that you used -- distillation Of course, their equipment is larger, but it is the same idea.

Student
page 2

A lot of our rainwater here in Jacksonville came from the ocean. The sun evaporated the water leaving the salts behind. Of course, rainwater is clean, pure water which is suitable for drinking. The navy base at Guantanamo, Cuba gets its water by distilling ocean water. They use a nuclear reactor to supply the heat to boil the water. Key West gets its water from the ocean also but they don't use nuclear energy. Jacksonville gets its water from deep wells. The water from these wells is pure and does not need to be distilled. The city adds chlorine and other things to kill germs, but we usually can't taste the chemicals.



TEACHER DIRECTION P - 40

CAN YOU PASS THE TASTE TEST?

Materials for groups of three:

1. Two sugar cubes
2. Beaker (250 ml)
3. Funnel
4. Stirring rod
5. Filter paper
6. Test tube

Using transparency P-40, review the procedure for setting up the apparatus for distillation, the same used in P-39. You will also need to demonstrate the folding of filter paper.

IN OUR ACTIVITY TODAY WE ARE GOING TO PUT OUR TASTE BUDS TO A TEST. DO YOU THINK THEY CAN PASS IT. Pause. LET'S BEGIN BY EXAMINING THE EQUIPMENT WE WILL NEED TO TRY THIS TEST. LOOK AT THE DIAGRAM ON THE SCREEN. NOTICE THE POSITION OF THE RING STAND AND CLAMP. THE END OF THE FUNNEL GOES DOWN INSIDE THE TEST TUBE.

NOW LET'S TAKE THE ROUND PIECE OF FILTER PAPER AND FOLD IT TO FIT INTO THE FUNNEL. TO MAKE THE FOLD CORRECTLY WE FIRST FOLD THE FILTER PAPER IN HALF, pause, AND THEN FOLD IT IN HALF AGAIN. OUR FILTER PAPER NOW LOOKS LIKE A PIECE OF PIE. (Pause). THIS IS THE MOST IMPORTANT STEP IN FOLDING THE FILTER PAPER. CUP THE FILTER PAPER IN ONE HAND AND PULL AWAY ONE SIDE, ONLY ONE THICKNESS OF THE PAPER SO THAT THE PEICE OF FILTER PAPER LOOKS LIKE A LITTLE CONE-SHAPED CUP. (Pause)

NOW WE ARE READY TO FIT THE FILTER PAPER CUP INSIDE OF THE FUNNEL. Demonstrate.

ADD WATER TO THE BEAKER UNTIL IT IS HALF FULL. DROP <u>ONE</u> CUBE OF SUGAR IN THE BEAKER. WATCH IT CAREFULLY TO SEE WHAT HAPPENS. (Discussion). HOW CAN YOU TELL WHEN THE DISSOLVING STOPS. Discussion. STIR THE SOLUTION TO BE SURE ALL OF THE SUGAR HAS DISSOLVED, THEN TASTE THE WATER IN THE BEAKER TO SEE IF YOU CAN TASTE THE SUGAR. (Discussion).

Teacher Direction
page 2

NOW DROP ANOTHER SUGAR CUBE INTO THE BEAKER. STIR. ALL OF THE SUGAR SHOULD DISSOLVE. FILTER THE SOLUTION AND TASTE THE FILTRATE. IF YOU CAN STILL TASTE THE SUGAR, DISTILL THE SOLUTION AND TASTE AGAIN.

Pass out P-40

STUDENT P - 40

CAN YOU PASS THE TASTE TEST?

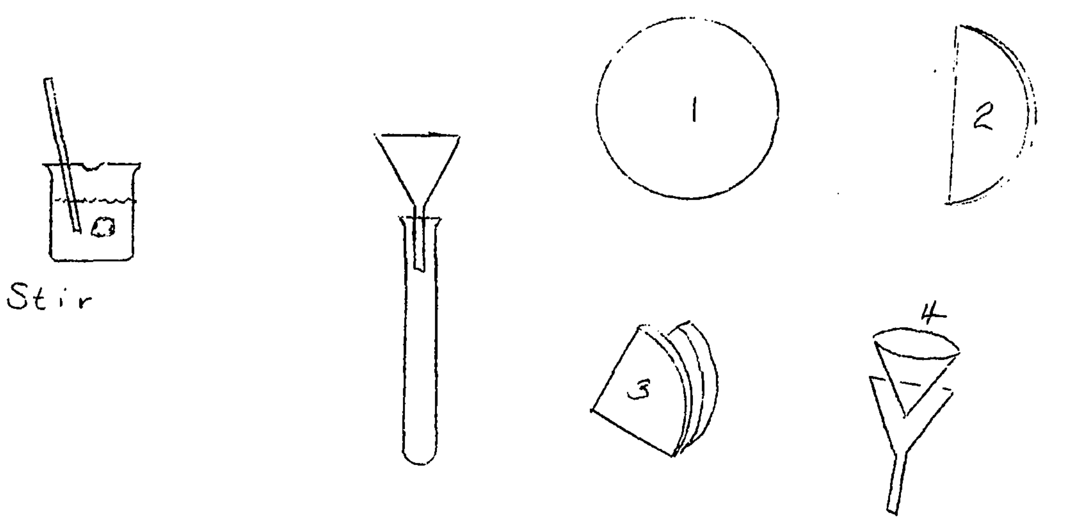
Materials for groups of three:

1. Two sugar cubes
2. Beaker (250 ml)
3. Funnel
4. Stirring rod
5. Filter paper
6. Test tube

We have distilled a solution of salt and water and removed the salt. What would happen if we distilled a solution of sugar and water. Well, we'll find out today.

But first, let's try to filter the sugar out of the water. Do you think we can do it?

This is going to take all three of you. While one person is dissolving two sugar cubes in water, another person needs to get the funnel and test tube ready while the other folds the filter paper.



Stir the sugar water again to make sure all the sugar has dissolved. How can you tell when all the sugar has dissolved?____________________________

Taste the sugar water — Can you taste the sugar?____________ Did all of you taste the sugar?____________. Now, let's try to remove the sugar from the water. Can we?

Student
page 2

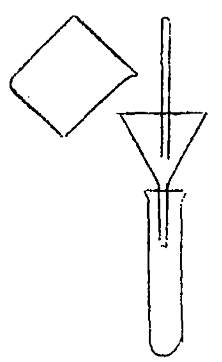
Place the filter paper in the funnel and pour the sugar solution into the filter paper. Use care not to let the solution level go above the top of the filter paper. After all has passed through the filter, taste the solution again. Can you taste any sugar?_______________ Can you filter sugar out of water?______________. Save the solution and if you have time, distill it to see if you can remove the sugar that way.

Now, mix some dirt with some water, stir, and filter. Did the water come out clean?___________ Is it clear?____________. Do not taste the water since the dirt may have had germs on it.

Is sugar water a solution or mixture?_________________

Is dirty water a solution or mixture?_________________

Pour Slowly



Topic 2 - Solution require different quantities of solids for saturation.

TEACHER RESOURCE

A saturated solution is one that contains as much of the solute as is possible to dissolve in a given quantity of solvent under given conditions. The given conditions usually refer to temperature — the higher the temperature of the solution, the greater the solubility. All solutions should be stirred to increase the rate of solution. Smaller crystals dissolve more quickly than large crystals.

A supersaturated solution is a solution that contains more than the quantity of solute normally possible. Rapid crystallization takes place when a tiny crystal of solute is dropped into such a solution.

A dilute or unsaturated solution is one that contains a very small amount of solute to a larger amount of solvent. The degree of dilution can vary and is usually indicated on the lable of the container.

All solutions will be made with water as the solvent (aqueous solutions) unless specifically stated to the contrary.

TEACHER DIRECTION

P - 41

FILL 'ER UP

Materials for groups of three:

1. Three beakers, 250 ml
2. Stirring rod
3. Spoon
4. Salt
5. Sugar
6. Sulfur, lump

This activity will show that all solid substances are not equally soluable in a liquid (water in this case). The students are to prepare three solutions using three different solids. They are to add the solids one teaspoon at a time and stir until no more will dissolve. Have them place an X in the chart each time more solid is added.

HOW MUCH SUGAR DO YOU PUT IN YOUR TEA? HOW MUCH SUGAR CAN YOU PUT IN YOUR TEA? Discussion. DOES IT ALL DISSOLVE? MAYBE ONE OF YOU GIRLS CAN TELL ME HOW MUCH SODA WILL DISSOLVE IN WATER, CAN YOU? Discussion. I'VE NEVER TRIED IT EITHER. DO YOU THINK THE SAME AMOUNT OF SUGAR AND SODA WILL DISSOLVE IN WATER? No. LET'S TRY DISSOLVING SOME MATERIALS IN WATER AND SEE IF THERE IS A DIFFERENCE IN THE AMOUNT THAT WILL DISSOLVE. Pass out P-41.

Using transparency P-41, instruct the students to label the beakers 1, 2, and 3. Then add water to each beaker until they are half full.

YOU HAVE THREE BEAKERS HALF FILLED WITH WATER AND NUMBERED 1, 2, and 3. TO THE FIRST BEAKER OF WATER, ADD ONE LEVEL SPOONFUL OF SALT AND STIR UNTIL ALL THE SALT DISSOLVES. Pause. IF ALL THE SALT DID DISSOLVE, PUT AN X IN THE FIRST SQUARE OF THE CHART. NOW ADD ANOTHER LEVEL SPOONFUL OF SALT AND STIR UNTIL ALL HAS DISSOLVED. IF ALL THE SALT DID DISSOLVE, PUT AN X ON YOUR CHART UNDER "2 SPOONS" AND THEN TRY TO GET ANOTHER SPOONFUL TO DISSOLVE. WHEN NO MORE SALT WILL DISSOLVE, THE SOLUTION WILL BE SATURATED.

Teacher Direction
page 2

Instruct the students to continue this procedure with sugar (beaker 2) and sulfur (beaker 3). Sulfur is insoluable in water and probably stimulate some discussion.

After the students have completed the activity, discuss the questions on the bottom of the student activity sheet. Differences in responses and data may be due to different size spoons, different quantity of water, not stirring sufficiently, or differences in water temperature.

STUDENT

P - 41

FILL 'ER UP

Materials for groups of three:

1. Beakers, 250 ml
2. Stirring rod
3. Spoon
4. Salt
5. Sugar
6. Sulfur

How sweet is sweet? If sweet is sweet, how sweet is sweeter? How salty can you make water? Can you make salty water saltier? Sur you can, up to a point. And then no more salt will dissolve in the water. The salt dissolved in water forms a solution. When no more salt will dissolve, we say the solution is saturated.

Salt and sugar look alike, but they taste different. Can you dissolve as much sugar in water as you can salt in water? How much sulfur?

Label your three beakers 1, 2 and 3. Add water to each beaker until half full. To the first beaker, add one level spoonful of salt and stir. If the salt dissolves, mark an X in the first square beside salt in the table on the next page. Add another spoonful of salt and stir. If it dissolves, mark an X in the second square beside salt in the table. Continue until the salt no longer dissolves and some is left in the bottom of the beaker.

To the second beaker, add sugar until no more dissolves. Be sure to record the amount of sugar you used. Do the same for sulfur in beaker 3.

Student
page 2

SOLUBILITY TABLE

Beaker No.	Solid	1 Spoon	2 Spoons	3 Spoons	4 Spoons	5 Spoons
1	Salt					
2	Sugar					
3	Sulfur					

How much salt could you dissolve in the water?_______________

How much sugar could you dissolve in the water?_____________

How much sulfur could you dissolve in the water?____________

If salt water is salty and sugar water is sweet, is the same amount of salt and sugar dissolved in the water?

How do you know when the solution is saturated.

TEACHER DIRECTION P - 42

A SUPER-DUPER SOLUTION

Materials for groups of three:

1. Beaker, 250 ml
2. Ring stand
3. Alcohol burner
4. Stirring rod
5. Thermometer
6. Soda

The amount of any substance that will go into solution in a given quantity of water (or any solvent) depends on temperature, pressure, and other factors. However, under any particular given set of conditions, a definite quantity of a substance will dissolve or go into solution. Generally, raising the temperature of a solution increases the amount of solid materials that may be dissolved into solution. Therefore, if a solution is saturated at any elevated temperature (say 140° F) and cooled slowly without crystals being reformed, it will be supersaturated. Care must be taken to not allow solid particles to come into contact with the supersaturated solution or recrystallization will take place.

Add water to a beaker until half full. HOW MUCH SODA DO YOU THINK WILL DISSOLVE INTO THIS WATER? Discussion. WE REALLY DON'T KNOW UNTIL WE TRY IT, SO THAT IS THE FIRST THING WE WILL HAVE TO DO. I THINK WE CAN GET MORE SODA TO DISSOLVE IF WE HEAT THE SOLUTION. WHAT DO YOU THINK? Discussion

Pass out P-42.

Teacher Direction
page 2

The students are to first make a saturated solution of soda, and then a supersaturated solution by heating the solution to about 180° F recording the amount of dissolved soda every 20° rise. A graph is then to be made of the data.

Using transparency P-42, FIRST, TO YOUR BEAKER OF WATER, ADD SODA UNTIL THE SOLUTION IS SATURATED. RECORD THE NUMBER OF SPOONFULS IT TOOK AND RECORD THE TEMPERATURE (Room temperature). HEAT THE SOLUTION AND CONTINUE TO ADD SODA A SPOONFUL AT A TIME. RECORD THE AMOUNT OF DISSOLVED SODA EVERY 20° RISE IN TEMPERATURE. THEN GRAPH YOUR DATA.

If time permits, you might want to show recrystallization. The next activity is a reading activity about growing crystals. If each group can save their supersaturated solution by pouring off the clear liquid and covering to prevent dust from settling on the surface, then they can use it for the next activity to show spontaneous recrystallization.

STUDENT P - 42

A SUPER-DUPER SOLUTION

Materials for groups of three:

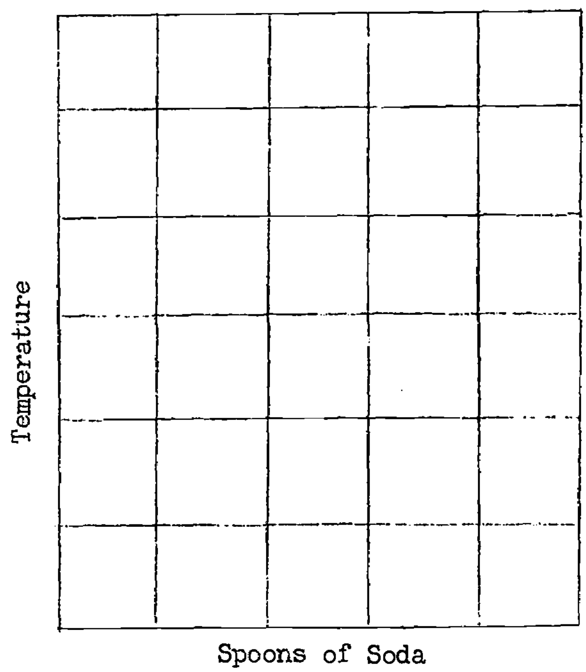
1. Beaker, 250 ml
2. Ring stand
3. Alcohol burner
4. Stirring rod
5. Thermometer
6. Soda

You have made a saturated solution before by adding salt or sugar to water until no more would dissolve. Now we want to make a supersaturated solution by heating the solution, adding more material, and then cooling the solution. We believe that heating the solution will allow more to dissolve, and we want to find out if it is also true for soda.

First, add water to a beaker until half full. Add soda, a level spoonful at a time, until the solution is saturated (no more will dissolve). Don't forget to stir. Record the number of spoonfuls you used and the temperature of the solution.

Next, heat the solution. Add a spoon of soda when all the other has dissolved. Record the amount of soda added at each 20° F interval. Continue until you reach 180° F.

SODA Added (Spoons)	TEMPERATURE OF SOLUTION



Student
page 2

When you have obtained the hot saturated solution, pour off the clear liquid into another beaker so that none of the undissolved soda is present in the solution. Then cover and save it for the next activity. When the solution cools, it will be a super-saturated solution.

TEACHER DIRECTION P - 43

CRYSTALS

Many solid materials are composed of crystals. We usually think of crystals as having flat faces and sharp edges that we can see such as diamonds. But small particles the size of dust usually have orderly arrangements of atoms and thus are crystalline.

This reading activity is presented in such a way that the supersaturated solutions from P-43 may be used but is not necessary. The discussion will center around recrystallization of supersaturated solutions. The next unit will involve the students in growing crystals.

STUDENT P - 43

CRYSTALS

Have you ever dreamed of finding a diamond, or ruby, or other expensive stone. Well, it's not impossible if you know where to look and what to look for. You could look for diamonds in the diamond mines of western Arkansas and keep all you find. But rough uncut diamonds may be hard to recognize.

If you don't want to dig for diamonds, you could travel to the mountains of North Carolina and search for rubies. But, like the diamonds, rough unpolished rubies may be difficult to recognize.

You have seen many other crystals and probably eat them regularly. Salt is a crystal which is dug out of the ground in large quantities in Louisiana, Texas, and New Mexico. How do you suppose the salt is cleaned before it is sold? How would you separate the dirt from the salt?

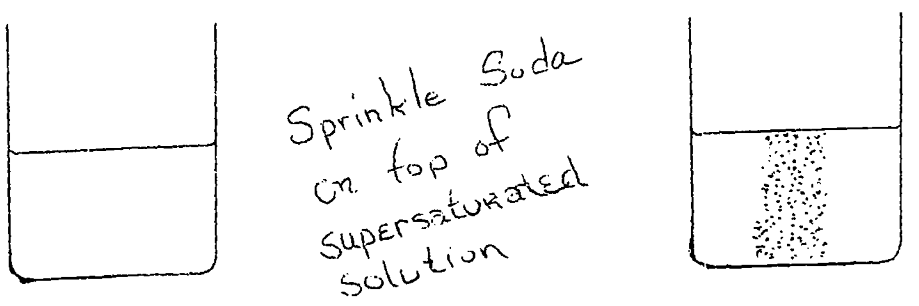
Sugar is a crystal, also. Sugar cane is a plant that grows in south Florida from which we get sugar. The cane is ground up and the juices extracted. How do you suppose the dry sugar crystals you buy in the store are preared from the juices of sugar cane?

You have prepared several saturated solutions recently by adding crystals to water until no more will dissolve. And you have prepared a supersaturated solution by heating the water, adding more solid material, and the cooling the solution.

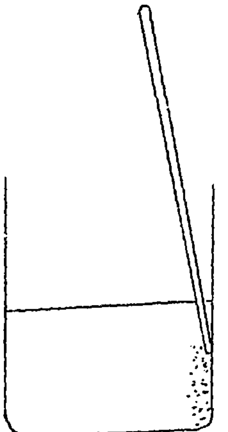
Let's try an experiment with your supersaturated solutions. Remember that you had to heat the solution to make more soda dissolve, that is, you have forced the water to hold more soda in solution at room temperature than it normally would. Therefore, given an opportunity, the extra soda will recrystallize and leave the dissolved state. There are several ways this can be done.

Student
page 2

One way you can cause the soda to recrystallize is to sprinkle some solid soda on top of the super-saturated solution. Try it and see what happens. After the crystals form, is your solution saturated or super-saturated.



Another way you can cause the soda to recrystallize is to scratch the side of the beaker. Take a glass stirring rod and rub it on the inside wall of the beaker scratching the glass. The rough edges of the scratch mark will cause the action to start.



Student
page 3

Do you have any ideas now how crystals could be cleaned? Do you think you could grow a big crystal rather than many small ones? I bet you can.

UNIT 8 - CRYSTALS AND CRYSTAL GROWING

Watching crystals grow from day to day stimulates many questions and suggests many experiments. Crystals are colorful and can be taken home and preserved for future study. The purpose of growing crystals in this unit is to point out the orderliness of crystals growth and that all crystals do not look alike. Making three-dimentional paper models of crystals will help the students see the geometric shapes.

The activities included in this unit are:

P-44	SHOOTING STARS
P-45	GROWING CRYSTALS
P-46	EPSOM SALT CRYSTALS
P-47	A CHEMICAL GARDEN
P-48	UNLOCKING WATER IN CRYSTALS
*P-49	TAKING ON WATER
P-50	CRYSTAL MODELS

TEACHER RESOURCE

Crystallization takes place as solutions evaporate. Evaporation causes the solution to become supersaturated which induces crystallization. Seed crystals are needed to start recrystallization and to give the crystal something to grow on, for crystals grow by adding on to the outside. Care must be exercised to keep the solution from becoming contaminated, for any dirt or dust particles can seed the solution or interfere with the natural growth and geometric shape of the crystal.

Crystals grow under many different conditions--some of them quite surprising. Snow flakes grow directly from moist air. Some crystals grow from hot melted metal. But the most familiar method of growing crystals is from a liquid solution--in other words, from a substance which evaporates while the solid separates out.

Almost all salts can be crystallized from the most abundant liquid, water. In our activities we will be using water as the liquid from which we crystallize various salts.

Two films available from the film library will be of interest and helpful to the students as they begin their study of crystals. These films are:

1. Crystals

2. Crystals and Their Structure

Ask the students to bring in small jars such as baby food jars or half-pint jars. Large jars are unsuitable for making crystals. Each student will need 2 jars. Have the students thoroughly clean all jars before the day of the experiment.

Topic 1 - Crystals can be grown from supersaturated solutions.

Crystals usually grow slowly unless forced to grow faster. However, forcing the crystals to grow faster, such as by heating the solution, usually produces poorly formed crystals. Two weeks should be sufficient time to grow fairly large crystals. The first activity, sodium acetate crystals, will be an exception.

WE ARE GOING TO BE GROWING CRYSTALS FOR THE NEXT SEVERAL ACTIVITIES. ALL THE CRYSTALS YOU GROW WILL BE YOURS TO KEEP AND TAKE HOME IF YOU WISH, SO DO A GOOD JOB. THE MOST IMPORTANT THING TO REMEMBER IS TO BE PATIENT AND KEEP YOUR GLASSWARE AND CHEMICALS CLEAN.

TEACHER DIRECTION P - 44

SHOOTING STARS

Materials for groups of three:

1. Beaker, 250 ml
2. Ring stand
3. Wire gauze
4. Alcohol lamp
5. Stirring rod
6. Sodium acetate

Have the students prepare the supersaturated solution of sodium acetate early in the class period and show the film on crystals while the solutions are cooling. After the solution cools, spontaneous recrystallization will occur upon seeding.

Pass out P-44

Teacher Direction
page 2

ADD WATER TO YOUR BEAKER UNTIL HALF FULL. SLOWLY ADD SODIUM ACETATE UNTIL YOUR SOLUTION IS SATURATED. HEAT TO 195° F (90°C) AND ADD SODIUM ACETATE UNTIL THE SOLUTION IS SATURATED. POUR OFF THE CLEAR SOLUTION INTO A CLEAN BEAKER AND LET COOL. This is a good time to either show a film or wash some glassware.

After the solution has cooled, WATCHING THE SOLUTION CLOSELY, DROP A CRYSTAL OF SODIUM ACETATE INTO THE BEAKER. Pause (Beautiful needle - like crystals should form immediately and shoot out in all directions. WHY DID WE WAIT UNTIL THE SOLUTION WAS COOL TO ADD THE SEED CRYSTAL? (Temperature affects saturation. The solution did not become supersaturated until cooled.)

WE FIND SUPERSATURATED SOLUTIONS AT HOME AS WELL AS IN THE LABORATORY. AT ROOM TEMPERATURE HONEY AND JELLY ARE SUPERSATURATED AND WE FIND SUGAR CRYSTALLIZING IN THEM. (Perhaps you have heard the expression "this jelly is going to sugar".) SOMETIMES PROPERLY MADE FUDGE CANDY WILL NOT HARDEN (crystallize) ON COOLING: IT IS SUPERSATURATED (sugar-water). THE FUDGE CAN BE MADE TO HARDEN BY ADDING JUST A VERY SMALL AMOUNT OF SUGAR (seeding).

STUDENT

P - 44

SHOOTING STARS

Materials for groups of three:

1. Beaker, 250 ml
2. Ring stand
3. Wire gauze
4. Alcohol lamp
5. Stirring rod
6. Sodium acetate

Most crystals require several weeks to properly grow into a large size. But we are going to make this one grow rapidly and it will take only a few seconds. So be sure to watch carefully.

Clean your glassware carefully, for any dirt will ruin your crystals. Add water to a beaker until half full. Add sodium acetate slowly until no more will dissolve. You now have a saturated solution.

Heat your solution using the alcohol burner, but don't let it boil. Add more sodium acetate until no more will dissolve. You now have a hot saturated solution. Pour the clear solution into another beaker making sure none of the solid particles go over. When this solution cools, it will be a super-saturated solution. Your instructor will adivse you when it is time to continue.

After the solution has cooled, add a small crystal of sodium acetate. Watch the solution closely.

What happened?

Draw a diagram of your crystals.

TEACHER DIRECTION

P - 45

GROWING CRYSTALS

Materials for groups of three:

1. Beaker, 600 ml
2. Baby food jars, small, 3
3. Thread and paper clip, 3
4. Ring stand
5. Wire gauze
6. Alcohol burner
7. Stirring rod
8. Alum

It will take about two weeks to grow the alum crystals. Daily observation on the progress can be made but the solutions should not be handled during the growing period. Use your judgement in determining when you want to stop the growth and let the students take their crystals home.

THE FIRST THING WE ALWAYS HAVE TO DO IN GROWING A CRYSTAL IS TO PREPARE A SUPERSATURATED SOLUTION. THIS TIME WE ARE GOING TO GROW AN ALUM CRYSTAL. IF YOU WORK CAREFULLY AND USE CLEAN GLASSWARE, YOU CAN GROW A WELL SHAPED, LARGE ALUM CRYSTAL. LETS SEE WHO CAN GROW THE BIGGEST AND BEST CRYSTAL. Discuss crystal growth.

ADD 400 ML WATER TO YOUR BEAKER. HEAT THE WATER UNTIL IT ALMOST BOILS AND ADD ALUM SLOWLY. STIR. WHEN THE SOLUTION IS SATURATED, POUR THE CLEAR SOLUTION INTO THE CLEAN BABY FOOD JARS. THE JARS SHOULD BE ABOUT TWO THIRDS FULL. LET THE JARS COOL.

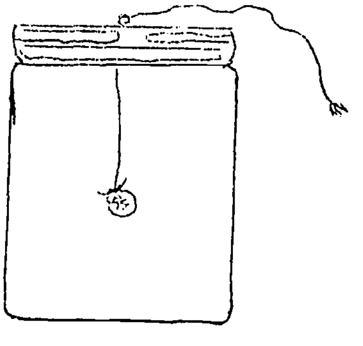
Instruct the students to punch a small hole in the baby food jar lid so that the thread may be inserted to hold the seed crystal. A nail is a good tool for this job. Show the film at this time if available. After the film the solution should be cooled enough to seed.

Pass out P-45

Teacher Direction
page 2

After the students have started, remind them that the seed crystal should not extend above the surface of the water but should be rather close to the bottom. The string not only support the growing crystal but also acts as a wick: as water evaporates from the wick the crystal grows.

Instruct the students to place their jars where they will not be disturbed and the temperature will be fairly constant.



STUDENT

P - 45

GROWING CRYSTALS

Materials for groups of three:

1. Beaker, 600 ml
2. Baby food jars, small, 3
3. Thread and paper clip, 3
4. Ring stand
5. Wire gauze
6. Alcohol burner
7. Stirring rod
8. Alum

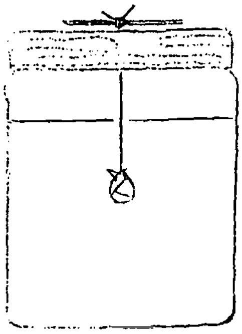
Today we are going to begin growing an alum crystal. It will probably take two weeks to grow a large one, so we can only set it up today and observe the crystal from day to day as it grows.

Add 400 ml of water to your beaker and begin heating. Be sure your beaker and baby food jars are clean, because your crystals will not grow properly if dirt is present. While the water is heating punch a small hole in your in your baby food jar lid and write your name on the lid.

Add two spoons of alum to your beaker of hot water and stir. Do not boil the water. Add a little more alum until no more will dissolve. While the saturated solution is still hot, pour the clear liquid into the three jars. Do not let any of the undissolved alum pour over into the jars. Let the solution cool slowly.

While the solution is cooling, tie a piece of thread to a seed crystal and run the other end of the thread through the hole in the lid so that the seed crystal will hang down into the solution. Do not tie the string at the lid yet; wait until the solution cools.

Student
page 2



Place the seeded solution in a safe place so that they will not be in direct sunlight. It will take two to three weeks for the crystals to grow large. Do not handle or shake the solution during this time.

TEACHER DIRECTION P - 46

EPSOM SALTS CRYSTALS

Materials for groups of three:

1. Beaker, 250 ml
2. Glass plates, 2" x 2", 3
3. Ring stand
4. Wire gauze
5. Magnesium sulfate, 4 spoons
6. Alcohol burner
7. Stirring rod
8. Glue, white
9. Cotton ball, small

This activity will provide the students with a fast and easy method of making crystal patterns on glass plates. You may want to have some of the students grow large crystals (which will take two weeks) so save the saturated solutions and seed them as you did with the alum crystals.

LET'S TRY AN EXPERIMENT TO SHOW THE SHAPE OF ANOTHER CRYSTAL - MAGNESIUM SULFATE. YOU HAVE PROBABLY SEEN MAGNESIUM SULFATE MANY TIMES. IT'S KNOWN AS EPSOM SALTS AND IS USED AS A MEDICINE.

ADD WATER TO YOUR BEAKER UNTIL IT IS $\frac{1}{4}$ FULL. HEAT THE WATER WITH THE ALCOHOL BURNER AND ADD EPSOM SALTS UNTIL THE SOLUTION IS SUPERSATURATED. This will take 3 or 4 spoonsful.

WHILE STILL HOT REMOVE THE BEAKER FROM THE RING STAND AND ADD TWO DROPS OF WHITE GLUE (Le Pages or Elmers or similar type) AND STIR. THEN USING A SMALL PIECE OF COTTON WIPE SOME OF THE MIXTURE ON A GLASS PLATE. WATCH THE GLASS PLATE CLOSELY FOR TWO OR THREE MINUTES. YOU SHOULD SEE THE CRYSTALS FORMING.

Pass out P-46

STUDENT

P - 46

EPSOM SALTS CRYSTALS

Materials for groups of three:

1. Beaker, 250 ml
2. Glass plates, 2" x 2", 3
3. Ring stand
4. Wire gauze
5. Magnesium sulfate
6. Alcohol burner
7. Stirring rod
8. Glue, white
9. Cotton ball, small

Magnesium sulfate is a white compound commonly known as epsom salts. Epsom salts is frequently used as either a foot bath for soaking tired dogs or is drank to help reduce the amount of water in the body. Have you ever drank any?

The first step in today's activity is to make a supersaturated solution of epsom salts. Remember how to do it? Just heat a beaker which is $\frac{1}{4}$ full of water until almost boiling and add epsom salts until no more will dissolve. It will probably take three or four spoonsful. Don't forget to stir.

Now that you have a supersaturated solution, set it off the burner onto the table. Don't forget that its hot. Add two drops of glue to the solution and stir thoroughly.

The next step is to take a small piece of cotton, dip it in the solution and wipe it on the glass plates. Then watch the plates for several minutes. Make a drawing of the crystals that form.

TEACHER DIRECTION P - 47

A CHEMICAL GARDEN

Materials for groups of three:

1. Beaker, 600 ml
2. Baby food jars, 3
3. Sand, 100 cc
4. Sodium silicate solution, 100 ml
5. Iron chloride crystals
6. Copper chloride crystals
7. Potassium nitrate crystals

IN THIS ACTIVITY WE ARE GOING TO GROW SOME UNUSUAL CRYSTALS. A CHEMICAL REACTION WILL TAKE PLACE THIS TIME BETWEEN THE SOLUTION AND SEED CRYSTALS. AFTER YOU HAVE DONE THE ACTIVITY YOU WILL SEE WHY IT IS USUALLY CALLED "GROWING A CHEMICAL GARDEN".

The sodium silicate, commonly known as water glass, will react with the seed crystals to form silicates. The crystals will rupture because of internal pressure and will build up layer upon layer.

EACH GROUP WILL NEED TO MIX 100 ML SODIUM SILICATE WITH 400 ML WATER IN YOUR 600 ML BEAKER. THIS WILL BE ENOUGH FOR ALL THREE IN THE GROUP. CLEAN YOUR BABY FOOD JARS AND ADD SAND TO THEM UNTIL IT IS ABOUT $\frac{1}{4}$ INCH DEEP. WRITE YOUR NAME ON YOUR JAR OR JAR LID. STIR THE SODIUM SILICATE SOLUTION WELL, THEN POUR IT INTO THE BABY FOOD JARS UNTIL ALMOST FULL. LET THE SAND SETTLE. SPRINKLE IN A SMALL QUANTITY OF THE CHEMICALS (sparingly). You can add magnesium sulfate to the list of chemical if you have some left over from the previous activity. NOW WATCH TO SEE WHAT HAPPENS.

Pass out P-47

Teacher Direction
page 2

Growth will start within a few minutes but several days will be needed to complete the garden. After the crystals have stopped growing siphon off the water glass solution (DO NOT POUR) and refill the jars with clear water. Then let the students take their chemical garden home. It should last for several months with gentle treatment.

STUDENT P - 47

A CHEMICAL GARDEN

Materials for groups of three:

1. Beaker, 600 ml
2. Baby food jars, 3
3. Sand, 100 cc
5. Iron chloride crystals
6. Copper chloride crystals
7. Potassium nitrate crystals

I bet you never have grown a chemical garden! Well, today we are going to grow "flowers" from chemicals. If you are real careful and gentle, a chemical garden can be yours to take home in several days. Be sure to write your name on your jar or jar lid.

Wash your glass beaker and baby food jars. They must be clean. Put some sand in the bottom of your baby food jar so that it is about $\frac{1}{4}$ inch deep.

$\frac{1}{4}$ inch

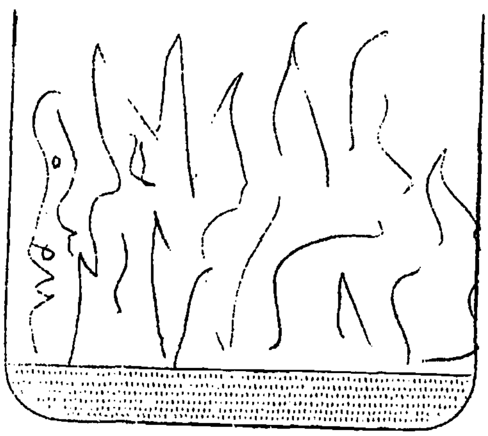
To your group's 600 ml beaker, add 100 ml sodium silicate and 400 ml water. Stir thoroughly. Pour this solution into the jars with the sand until they are almost full. Let the sand settle to the bottom. Carefully and sparingly add a few crystals of each chemical supplied by your instructor to the jars. Watch what happens.

The crystals will break open and a chemical reaction will take place. The newly formed crystals will then build up layer upon layer. We have already learned that crystals grow from one layer building upon another layer. In a few days you will find that the crystals will have grown into a beautifully colored garden.

Student
page 2

You can preserve this garden after the crystals have stopped growing by siphoning off (NOT POURING) the original solution and replacing it with clear water. Then you may take the chemical garden home. Be careful; they are fragile.

How is your alum crystal today?



TEACHER DIRECTION P - 48

UNLOCKING WATER IN CRYSTALS

Materials for groups of three:

1. Test tube
2. Test tube clamp
3. Alcohol burner
4. Sodium borate
5. Copper sulfate

Many crystals will absorb water from the air -- some will actually absorb enough water to go into solution. This activity will show the presence of water in sodium borate by heating the crystal gently and listening to the water boil. The presence of water can also be detected by heating copper sulfate. The crystals will change color upon heating and will change back to the original color upon standing in air.

WHAT SEEMS LIKE PERFECTLY DRY CRYSTALS MAY OFTEN HAVE WATER LOCKED IN THEM. ONE WAY WE CAN TELL IS TO HEAT THE CRYSTALS TO DRIVE OFF ANY WATER THAT IS PRESENT. SODIUM BORATE AND COPPER SULFATE ARE TWO COMPOUNDS THAT WE CAN USE. CAN YOU THINK OF OTHERS?

LET'S HEAT SOME SODIUM BORATE IN A TEST TUBE AND SEE WHAT HAPPENS. HEAT IT GENTLY AND DO NOT POINT IT TOWARD ANYBODY. AFTER HEATING FOR A MINUTE, HOLD THE TEST TUBE UP IN YOUR EAR -- CAREFUL, IT'S HOT -- AND LISTEN TO IT CRACKLE.

NEXT, HEAT SOME COPPER SULFATE IN A TEST TUBE AND NOTICE WHAT HAPPENS.

Pass out P-48

STUDENT P - 48

UNLOCKING WATER IN CRYSTALS

Materials for groups of three:

1. Test tube
2. Test tube clamp
3. Alcohol burner
4. Sodium borate
5. Copper sulfate

Many crystals contain water which can be removed by heating. Upon cooling and being exposed to moist air the crystals will reabsorb water. Some will even absorb enough moisture to cause them to dissolve into solution. Sal soda washing powder, borax, sodium borate and copper sulfate are some compounds which absorb water.

How can we tell if crystals contain water? Well one way is to heat them and notice if you can detect any change. You could listen for a crackling noise caused by water boiling out of the crystals. Some crystals will burst or spatter when heated so be careful. Also, some crystals will change color when heated as the water is boiled away. Remember, you can't see the water; you can only see or hear the changes caused by the water.

Put a spoonful of sodium borate in a test tube and heat it. Listen carefully. What do you hear?

Put a spoonful of copper sulfate in a test tube and heat it? What happens?

STUDENT

P - 49

TAKING ON WATER

Last night I tried to salt my hamburger but the salt wouldn't come out. It had absorbed moisture from the air and the salt crystals had stuck together. Has this ever happened to you?

Other things will absorb moisture from the air also. Remember in the last activity you heated copper sulfate and it changed colors, from blue to white. We said the color change was due to driving off the water by heating. Do you suppose the crystals will turn blue again if the water is replaced? Ask your instructor for some copper sulfate and find out.

A lot of materials will take on water from the air. This is one reason we keep things tightly sealed. The scientist has a special name for this characteristic of absorbing water; it is hygroscopic. Some materials really get carried away and absorb so much water they become completely dissolved and form a solution. Can you think of any examples? Ask your mother for she will probably know of some. Scientist call these materials that will take on enough water to form solution deliquescent.

Some solid substances you might want to use to investigate taking on water are: calcium chloride, sodium hydroxide, sodium sulfate, and potassium carbonate.

TEACHER DIRECTION

P - 50

CRYSTAL MODELS

Materials for groups of three:

1. Scissors
2. Glue

Making paper models of crystals is a good way to emphasize the regularity of crystalline shapes. Only one model is included, the alum crystal, but other patterns can be located in the library. It is suggested that students be assigned to prepare others. With a little patience and careful cutting, very nice models can be prepared from poster paper and other heavy paper.

Using transparency P-50, YOU HAVE GROWN AN ALUM CRYSTAL FROM A SATURATED SOLUTION, AND MOST OF YOU HAVE DONE A GOOD JOB. NOW LET'S MAKE A MODEL OF THE ALUM CRYSTAL OUT OF PAPER TO BETTER SEE JUST WHAT THE CRYSTAL LOOKS LIKE.

Pass out P-50

CUT OUT THE PATTERN OF THE ALUM CRYSTAL CUTTING ONLY THE OUTSIDE LINES. (Pause for cutting) FOLD THE PAPER SO THAT YOU CREASE EACH LINE. Pause. TUCK THE FLAPS UNDER AND GLUE THE MODEL TOGETHER. Some trimming may be necessary if the model does not fit together smoothly.

STUDENT

P - 50

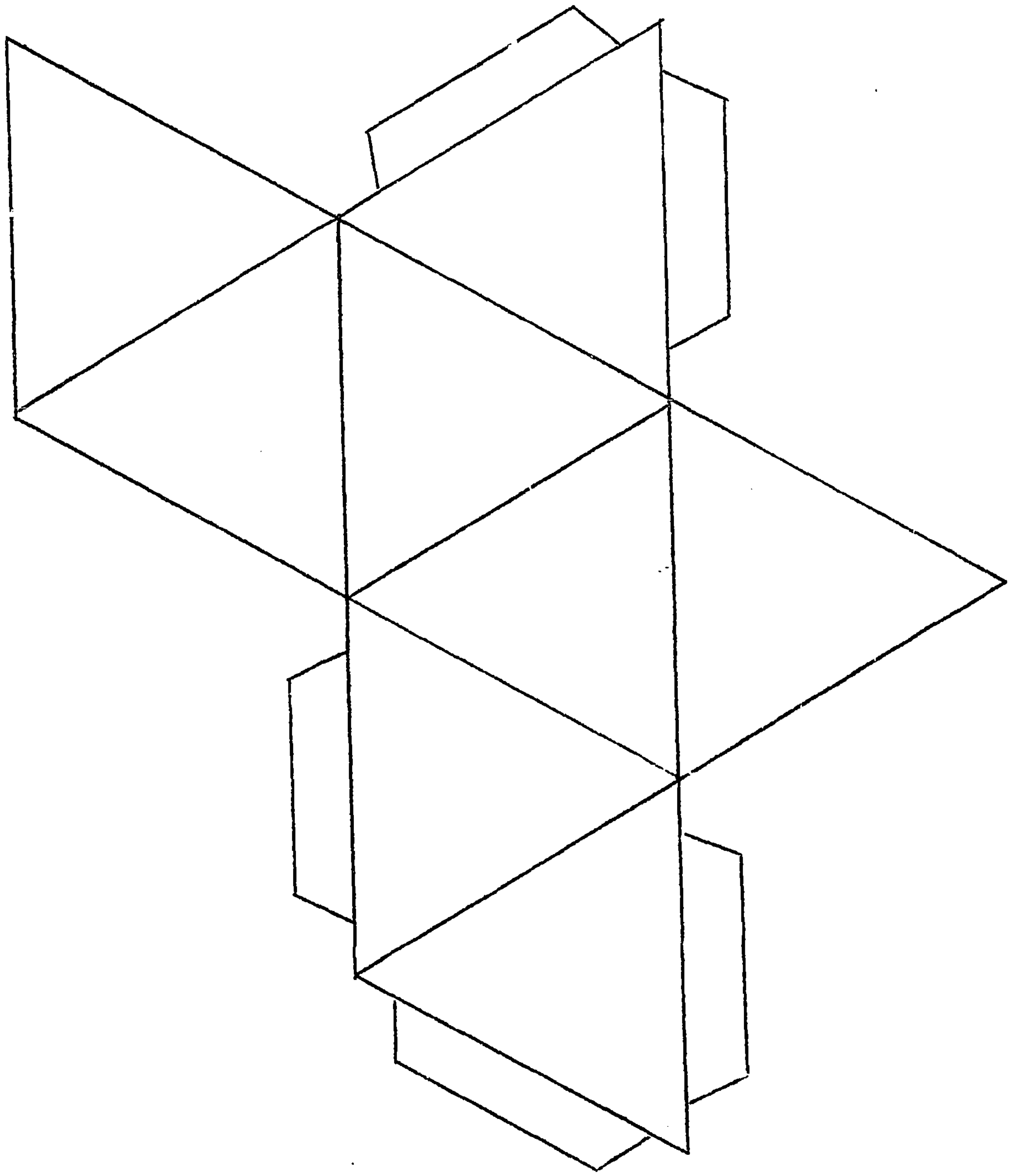
CRYSTAL MODELS

Crystal models are fun to make and help us see what our crystals are supposed to look like. A pattern for the alum crystal is on the next page. Cut it out, fold along the lines, tuck in the flaps, and glue the model together. If you are careful in cutting and folding you will have a neat crystal to take home.

The crystal you will make is an alum crystal. You already know that it looks like a double 4-sided pyramid for you have grown one recently. Does your model look like your crystal?

If you want to make other models, maybe even larger, ask your librarian to help you find patterns of other shapes (geometric solids or polygons). Your instructor can also help you build others.

Student
page 2



ALUM CRYSTAL

UNIT 9 — USING ELECTRICITY

This unit will show the student several practical applications of electricity such as electroplating, electrolysis and magnetism. However, little will be mentioned about the theories relevant to electricity and magnetism. The activities should generate some "how" questions which may be pursued at the descretion of the instructor.

The activities included in this unit are:

P-51	ELECTROPLATING WITH COPPER
P-52	CHROME PLATING
P-53	CONDUCTIVITY
P-54	ELECTROLYSIS OF WATER
P-55	GRAPEFRUIT BATTERY
P-56	MORE BATTERIES
P-57	MAGNETS
P-58	ELECTROMAGNETS

TEACHER DIRECTION P - 51

ELECTROPLATING WITH COPPER

Materials for groups of three:

1. Copper Sulfate, 5 grams
2. Hydrochloric acid, dilute, 20 ml
3. Dry cells, 1.5 v, 2
4. Bell wire, 18 inches, 3
5. Copper wire, 3 inches
6. Carbon rod, 3 inches
7. Nails, 2
8. Beaker, 250 ml, 2

Copper plating is probably the easiest procedure in electroplating. Th students are to use the dilute acid to clean the nails before plating. This will help the plating to be even and smooth. Five grams of copper sulfate i 100 ml water will make an adequate solution. Let the students try several alternatives in attaching electrodes to the battery. For the desired results, attach the nail or metal to be plated to the positive terminal of the battery. Use transparency P-51 to discuss the activity.

Pass out P-51

STUDENT

P - 51

ELECTROPLATING WITH COPPER

Materials for groups of three:

1. Copper sulfate, 5 grams
2. Hydrochloric acid, dilute, 20 ml
3. Dry cells, 1.5 v, 2
4. Bell Wire, 18 inches, 2
5. Copper wire, 3 inches
6. Carbon rod, 3 inches
7. Nails, 2
8. Beaker, 250 ml, 2

Electroplating is a big business today and many of the things we use everyday are plated, such as jewelry. There are several places that electroplate right here in Jacksonville. But don't get electroplating confused with galvanizing. When you galvanize something, such as a bucket or garbage can, the can is dipped into hot, molten zinc, lifted up and drained, and cooled. Electricity is not needed.

But electroplating involves the use of electricity to cause a metal, copper in this activity, to plate out or become attached to another metal. It takes good technique to do a good job, though. And, as always, your apparatus must be clean.

Pour 20 ml acid into the beaker and drop in the nails. This will clean the grease and rust off them and is called "pickling".

Add about 150 ml water to the other beaker and stir in 5 grams copper sulfate. Wash the nails in clean water to remove the acid and attach one of them to the positive (+) terminal on the battery using a length of bell wire. Attach the carbon rod to the negative (-) terminal of the battery using the other length of wire. Both the nail and carbon rod should be immersed in the copper sulfate solution, but not touching each other. Watch the nail and carbon for ten minutes to see if anything happens.

Student
page 2

Try other arrangements using the other nail and some copper wire as electrodes. Also, try dropping a nail into the solution and just let it lay there.

Draw diagrams to illustrate your activities.

TEACHER DIRECTION

P - 52

CHROME PLATING

Materials for groups of three:

1. Chrome sulfate, 5 grams
2. Hydrochloric acid, dilute, 20 ml
3. Dry cells, 1.5 v, 2
4. Bell wire, 18 inches, 3
5. Copper wire, 3 inches
6. Carbon rod, 3 inches
7. Nails, 2
8. Beaker, 250 ml, 2

This activity is similar to the previous one in copperplating. Chrome plating is more difficult and you might encourage the students to vary the concentration of the plating solution, the batteries and try stirring. You might also let them try to chrome plate some object of their choice. Use transparency P-52 to discuss the activity.

Pass out P-52

STUDENT

P - 52

CHROME PLATING

Materials for groups of three:

1. Chrome Sulfate, 5 grams
2. Hydrochloric acid, dilute, 20 ml
3. Dry cells, 1.5 v, 2
4. Bell wire, 18 inches, 3
5. Copper wire, 3 inches
6. Carbon Rod, 3 inches
7. Nails, 2
8. Beaker, 250 ml, 2

You have copper plated a nail and probably did a good job. You even discovered that you can copper plate a nail just by leaving it in the copper sulfate solution for several minutes. But the plating is rough and does not stick very well. Do you think you can chrome plate a nail the same way? Try it.

Try to chrome plate a nail better than your friends in class. You might even visit a chrome plating plant downtown.

Use the same procedure for this activity you did for the last one. Good Luck.

TEACHER DIRECTION

P - 53

CONDUCTIVITY

Materials for groups of three:

1. Beaker, 100 ml, 2
2. Sodium chloride, 5 grams
3. Hydrochloric acid, dilute, 50 ml
4. Sugar, 5 grams
5. Vinegar, 50 ml
6. Dry cells, 1.5 v, 2
7. Light with socket
8. Bell wire, 18 inches, 2

The ability of various solutions to conduct an electric current can be indicating by allowing the solution to close a circuit. Use transparency P-53 to assist the students in setting up their apparatus. The area of the electrodes in contact with the solution will effect the conductivity and will be noticeable in some solutions, such as vinegar. The brightness of the light will indicate the degree of conductivity; a dim light indicates poor conductivity. Let the students follow directions and experiment

Pass out P-53

STUDENT P - 53

CONDUCTIVITY

Materials for groups of three:

1. Beaker, 100 ml, 2
2. Sodium chloride, 5 grams
3. Hydrochloric acid, dilute, 50 ml
4. Sugar, 5 grams
5. Vinegar, 50 ml
6. Dry cell, 1.5 v, 2
7. Light with socket
8. Bell wire, 18 inches, 2

Some solutions can conduct electricity. This you know because you used electricity to copper plate and chrome plate some objects. But all solutions will not conduct electricity, or will they? Lets' find out.

Connect your light bulb and socket to the dry cell as shown in the transparency. Take a metal object and allow it to touch both of the electrodes on the bottom of the socket at the same time. The light glows brightly doesn't it. Remember this, for it tells you that these two electrodes must be connected by a conductor for the light to glow.

Pour 50 ml of water into your beaker and dip the electrodes into the water. Does the light glow? Add a small amount of sodium chloride (table salt) and see what happens. Add a little more, then a lot. Does the light glow now? Does salt water conduct electricity?

Pour out the salt water, wash the beaker, and pour in 50 ml hydrochloric acid. Does the acid conduct electricity?

Try vinegar and sugar water. Maybe you can find some other things to try.

TEACHER DIRECTION P - 54

ELECTROLYSIS OF WATER

Materials for groups of three:

1. Beaker, 250 ml
2. Test tubes, 2
3. Bell wire, 18 inches, 2
4. Dry cells, 1.5 v, 2
5. Sulfuric acid, dilute, 5 ml
6. Aluminum Foil, 1" x ½", 2
7. Wood splint
8. Matches

Most students have heard water called H - 2 - 0 and a short explanation of the meaning of the formula of water, H_2O, will be needed.

This activity will demonstrate that water is indeed made up of two parts hydrogen and one part oxygen. The sulfuric acid must be added to the water. water will not conduct electricity.

The low voltage being used will cause the gases to evolve slowly. Connecting the cells in series will speed up the decomposition. Attaching the foil to the end of the electrodes will increase the surface area and also hasten the decomposition. Do not scrape the insulation off the wire except the ends, for you want to collect all the gases.

STUDENT

P - 54

ELECTROLYSIS OF WATER

Materials for groups of three:

1. Beaker, 250 ml
2. Test tubes, 2
3. Bell wire, 12 inches, 2
4. Dry cells, 1.5 v, 2
5. Sulfuric acid, dilute, 5 ml
6. Aluminum foil, 1" x ½", 2
7. Wood splint
8. Matches

You have probably called water H_2O before because that is the chemical formula for water. Do you know what it means? Well, H_2O tells you that water is made up of two parts hydrogen and one part oxygen. That is, if you take two quarts of hydrogen and one quart of oxygen and combine them chemically, you would make a drop of water.

It is difficult to make water that way, but it's not too hard to divide water into hydrogen and oxygen. We do it with electricity and call the process electrolysis. Look at the transparency your instructor is projecting on the screen. Set up your apparatus as it is in the projection. Remember these things:

1. The water in the beaker must have acid in it.
2. The test tubes must be full of water.
3. The wire must be insulated except on the ends.
4. The foil speeds up the reactions.
5. Oxygen will be envolved from the positive (+) electrode.

When one test tube is full of gas and all the water has been forced out, pick it up slowly, keep it up-side-down, and stick a match to the mouth of the test tube. Be careful, for it should explode with a loud POP. Keep your hand to the side of the test tube.

Student
page 2

Carefully remove the other test tube from the beaker and immediately stick a match in the mouth of the test tube. It was only half full - you have to pour the water out first. What happens?

Which was hydrogen?

Which was oxygen?

TEACHER DIRECTION

P - 55

GRAPEFRUIT BATTERY

Materials for groups of three:

1. Beaker, 250 ml
2. Copper strip
3. Zinc strip
4. Bell wire, 18 inches, 2
5. Compass
6. Grapefruit
7. Other fruits

You may want to demonstrate the grapefruit battery using several of the grapefruits the students are to use. Connect them in parallel, that is all the copper electrodes attached together and all the zinc electrodes attached together. Connecting the ends of the wires together and looping around a compass will show that an electron flow is occuring. The current generates a magnetic field which deflects the compass. Three or four grapefruits should be adequate. Other fruit can be used for it is the acidic property of the juices that permits conductivity. Let the students experiment to determine how to make the strongest battery.

Pass out P-55

STUDENT

P - 55

GRAPEFRUIT BATTERY

Materials for groups of three:

1. Beaker, 250 ml
2. Copper strip
3. Zinc strip
4. Bell wire, 18 inches, 2
5. Compass
6. Grapefruit
7. Other fruits

Do you know what liquid is in your car battery? Sulfuric acid! Would another acid also work? Probably but not as efficiently and economically.

A grapefruit has an acid init. Do you suppose it could act like a battery? Probably, but not very strong. Maybe if you connected several grapefruits together it would make a strong battery. Lets' see.

Look at the transparency projection to see how to make your grapefruit into a battery. All you do is insert the copper and zinc strips into the grapefruit and connect the wires to them. Make sure the strips do not touch each other.

Loop one of the wires from the strips around a compass and connect the end of the wire to the end of the other wire. Now you have a circuit from the zinc strip, around the compass, and back to the copper strip in the grapefruit. If the grapefruit will conduct electricity, then we have a closed circuit and electricity can flow. If electricity flows, the compass needle will move. Did it move?

Borrow your neighbor's grapefruit battery and hook it to yours. Connect the wire from his zinc strip to your zinc strip and from his copper strip to your copper strip. Now what happens to the compass?

How about trying a third grapefruit.

Squeeze the juice out of a couple of grapefruits into the beaker and see if you can make a battery out of the juice.

TEACHER DIRECTION P - 56

MORE BATTERIES

Materials for groups of three:

1. Beaker, 100 ml
2. Vinegar, 50 ml
3. Sulfuric acid, dilute, 50 ml
4. Copper sulfate, dilute, 50 ml
5. Sodium chloride, dilute, 50 ml
6. Water, 50 ml
8. Copper strip, 2
9. Zinc strips, 2
10. Aluminum strips, 2
11. Magnesium strips, 2
12. Bell wire, 18 inches, 2

This activity is to demonstrate the makeup of a cell. Have the students set up their apparatus as shown on transparency P-56.

Each group is to test each solution with all the different combinations of strips that can be arranged. Remind them to clean their electrodes after each use in each solution.

Pass cut P-56

STUDENT P - 56

MORE BATTERIES

Materials for groups of three:

1. Beaker, 100 ml
2. Vinegar, 50 ml
3. Sulfuric acid, dilute, 50 ml
4. Copper sulfate, dilute, 50 ml
5. Sodium chloride, dilute, 50 ml
6. Water, 50 ml
8. Copper strips, 2
9. Zinc strips, 2
10. Aluminum strips, 2
11. Magnesium strips, 2
12. Bell wire, 18 inches, 2

We have seen evidence of electric current in such a common thing as a grape fruit. Now we want to see if we can generate electricity in several different solution using various metals as electrodes.

You are to use 5 different solutions and all the combinations of electrodes. Measure the strength of the "Battery" by noting the amount of deflection of the compass. Be sure to rinse the electrodes and the beaker between uses and after changing solutions. Make a chart to record your data and report your strongest battery.

TEACHER DIRECTION

P - 57

MAGNETS

Materials for groups of three:

1. Bar magnets, 2
2. Compass
3. Iron filings
4. Nail

This activity will show magnetic lines of force, attraction, repulsion, and making magnets. Let the students investigate freely. Caution them against allowing the iron filings to come into direct contact with the magnets; they are hard to remove.

Pass out P-57

STUDENT

P - 57

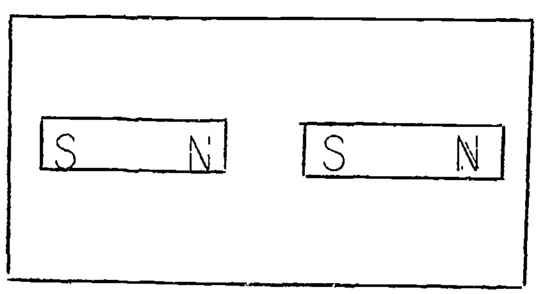
MAGNETS

Materials for groups of three:

1. Bar magnets
2. Compass
3. Iron filings
4. Nail

Have you ever wondered how a compass can always point north? The earth acts like it has a big magnet running from the South to North Poles. This causes all other magnets to try to line up with the Earth's magnetic field. Remember that like poles repel each other and unlike poles attract each other, that is, a north pole of a magnet will attract a south pole but repel another north pole.

Lay the two magnets down so that the south pole of one magnet is close to the north pole of the other magnet. Cover the magnets with a sheet of paper and gently sprinkle iron filings one the magnets.



Hold the compass close to the paper and see what effect it has on the compass needle.

Now reverse one of the magnets so that both north ends point toward each other. Pour the iron filings back into the shaker to reuse. Now sprinkle the iron filings over the paper. Try other arrangements of magnets and try their influence on the compass.

Lay the nail on one of the magnets near the end for five minutes. Is it magnetized?

TEACHER DIRECTION

P - 58

ELECTROMAGNETS

Materials for groups of three:

1. Thread spool
2. Bell wire, 48 inches
3. Dry cell, 1.5 v, 2
4. Nail, large

The students are to make an electromagnet by wrapping wire around a spool. The wire can be wrapped around the nail directly. Always use insulated wire.

When more than one cell is used, they should be connected in series.

Pass out P-58

STUDENT

P - 58

ELECTROMAGNETS

Materials for groups of three:

1. Thread spool
2. Bell wire, 48 inches
3. Dry cell, 1.5 v, 2
4. Nail, large

You have all seen magnets and noticed how magnets pick up certain metallic objects. It would be interesting to be able to make a magnet out of some very common materials, a magnet that we can turn on and off at will. It would also be fun to know how we can make a magnet, such as the one we will make, attract more. We can call this homemade magnet an electro magnet because its magnetic properties are produced from electricity.

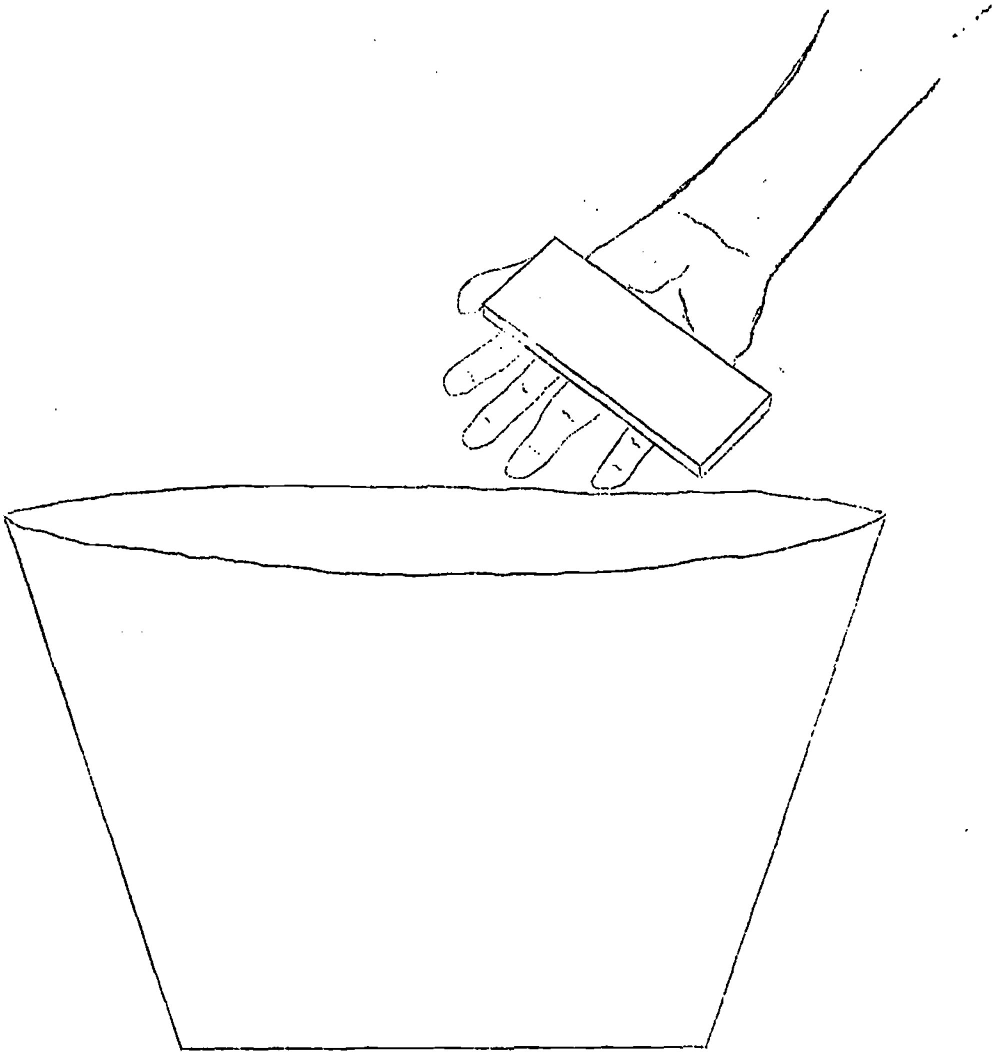
Wrap the wire around the spool.forty times leaving about a foot left over at either end. Now connect the wires to one dry cell as shown on the transparency. Try to pick up some paper clips with the spool. Do not keep the battery connected for a long time because this will run down the cell rapidly. How many paper clips can you get to stick onto the magnet?

Disconnect the magnet and wrap the wire around the spool over the first layer so that you have a double layer of about 40 wraps each. How many paper clips will it pick up now?

Connect another battery as shown on the transparency and see if more paper clips can be picked up.

Test the magnets attraction to other objects around you. What sort of things are attracted to the magnet? Stick the nail through the hole of the spool and see how this effects the strength of the electromagnet.

P-29



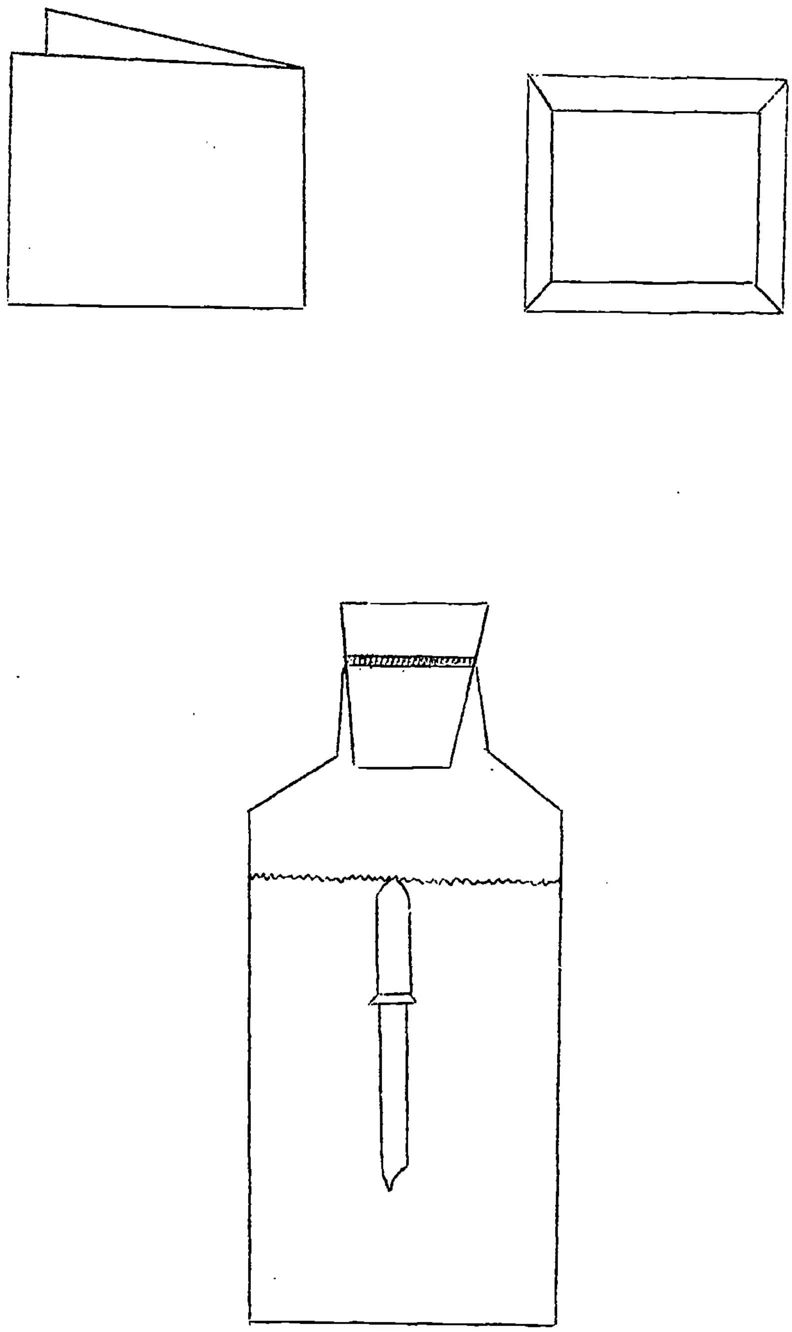
P-29

STUDENT 1	OBJECT	DRY WEIGHT	WET WEIGHT
	BRICK		
	WOOD		
	STYROFOAM		

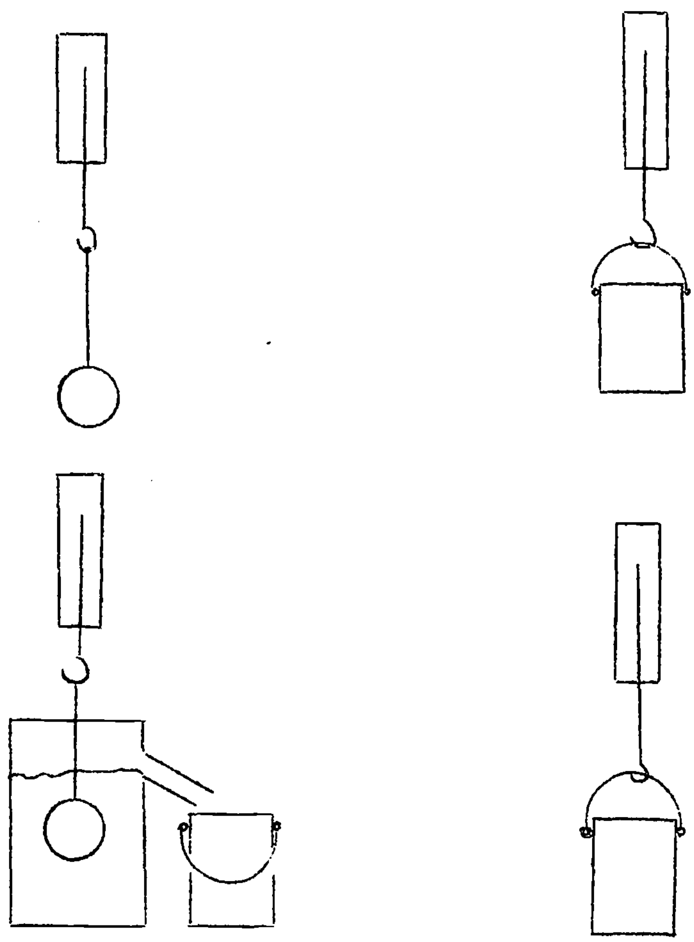
STUDENT 2	OBJECT	DRY WEIGHT	WET WEIGHT
	BRICK		
	WOOD		
	STYROFOAM		

STUDENT 3	OBJECT	DRY WEIGHT	WET WEIGHT
	BRICK		
	WOOD		
	STYROFOAM		

P-3©



P-31

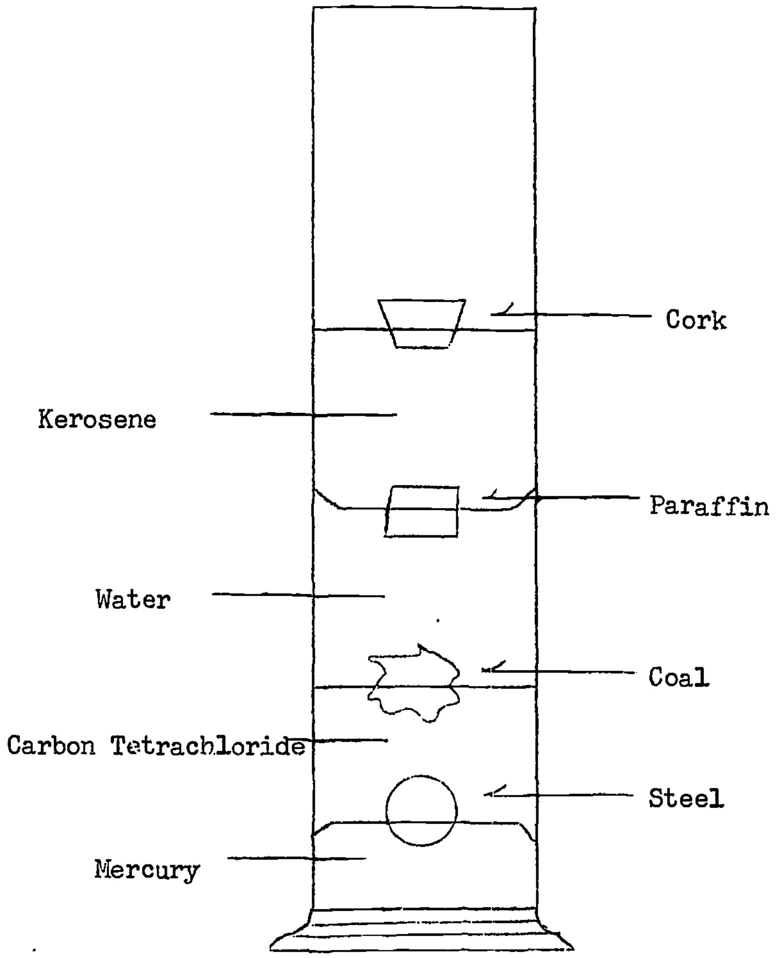


P-32

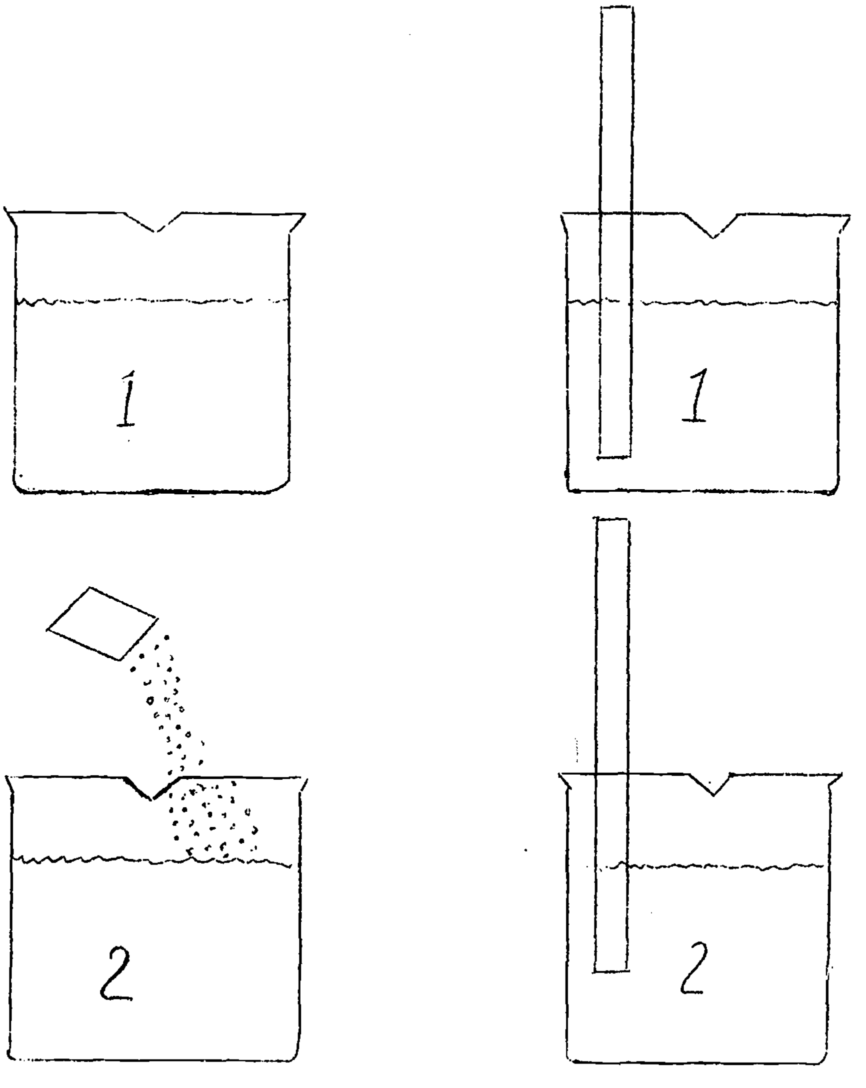
Metal	Weight in Air	Weight in Water	D
1			
2			
3			

$$D = \frac{\text{Weight of metal in air}}{\text{Weight in air - weight in water}} = \frac{\text{Weight}}{\text{Volume}}$$

P-33


Cork
Kerosene
Paraffin
Water
Coal
Carbon Tetrachloride
Steel
Mercury

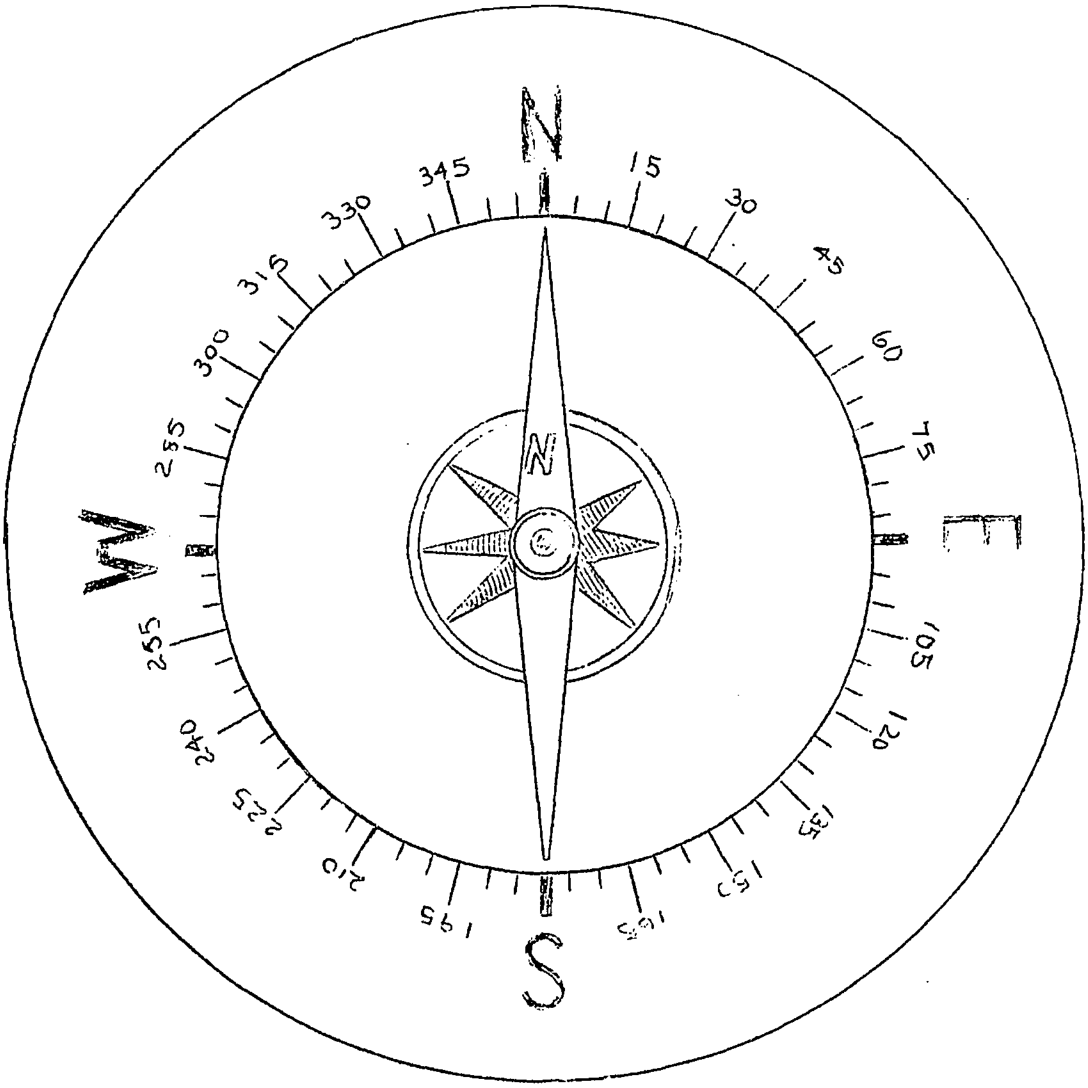
P-33



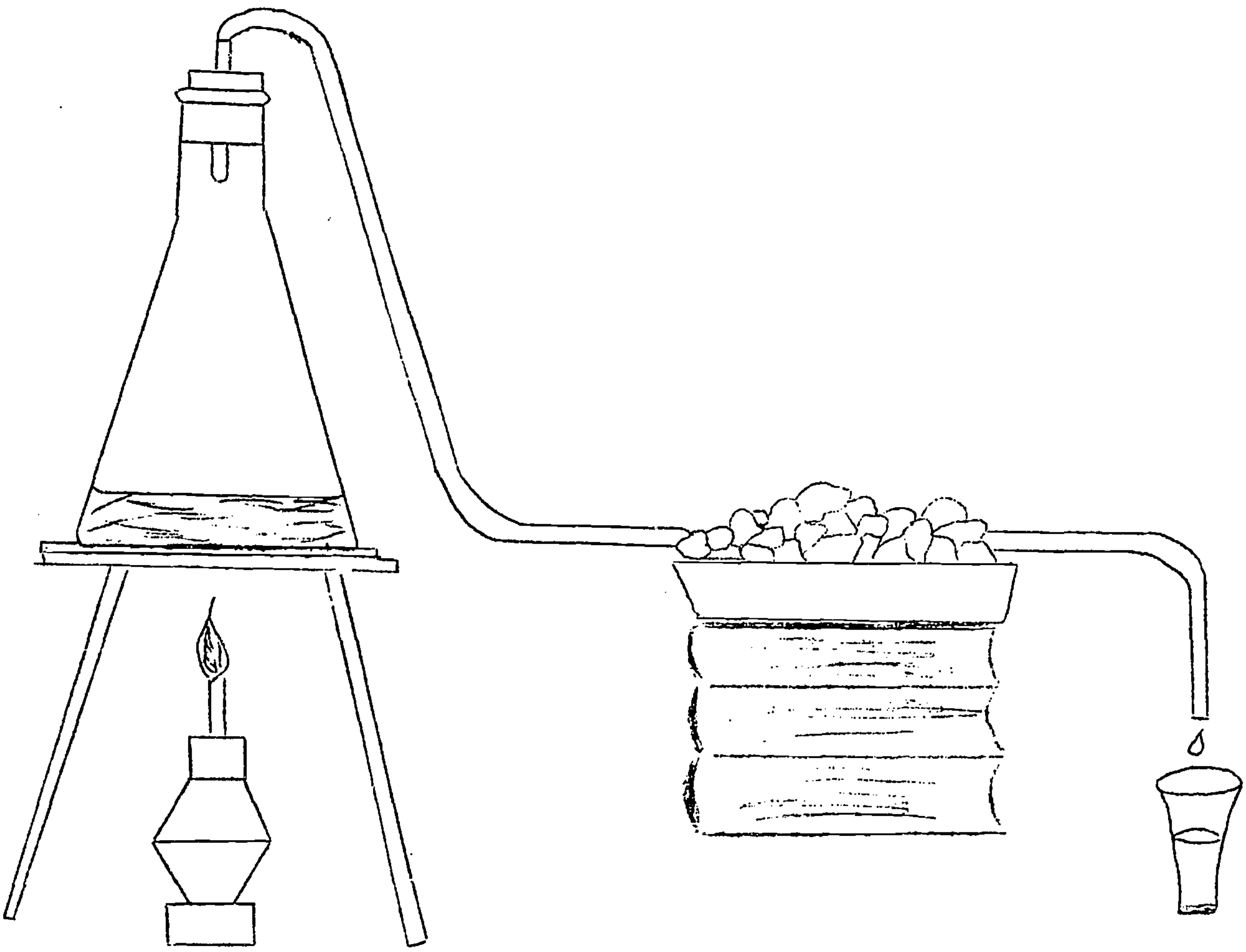
P 34

LIQUID	DENSITY	SOLID	DENSITY
Gasoline	.70	Cork	.25
Alcohol	.80	Aluminium	2.7
Water	1.00	Iron	7.5
Glycerine	1.25	Silver	10.5
Mercury	13.6	Lead	11.5
		Gold	19.0
		Platinum	21.5

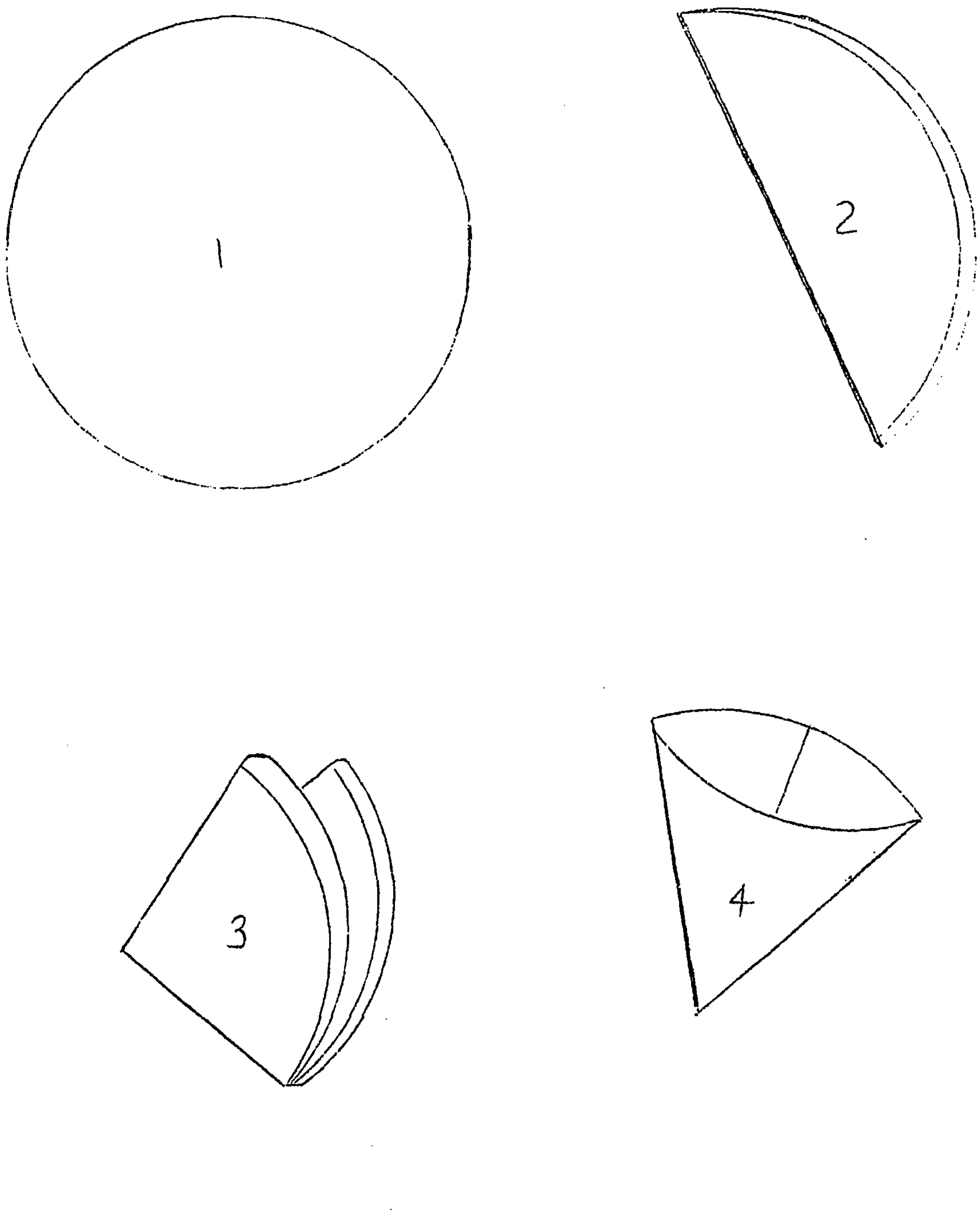
P35


N
345
15
330
30
315
45
300
60
255
75
W
E
255
105
240
120
225
135
210
150
195
165
S
N

P-39



P-40



HOW TO FOLD FILTER PAPER

P-41

Beaker No.	Solid	1 Spoons	2 Spoons	3 Spoons	4 Spoons	5 Spoons
1	Salt					
2	Sugar					
3	Sulfur					

How much salt could you dissolve in the water?________________

How much sugar could you dissolve in the water?________________

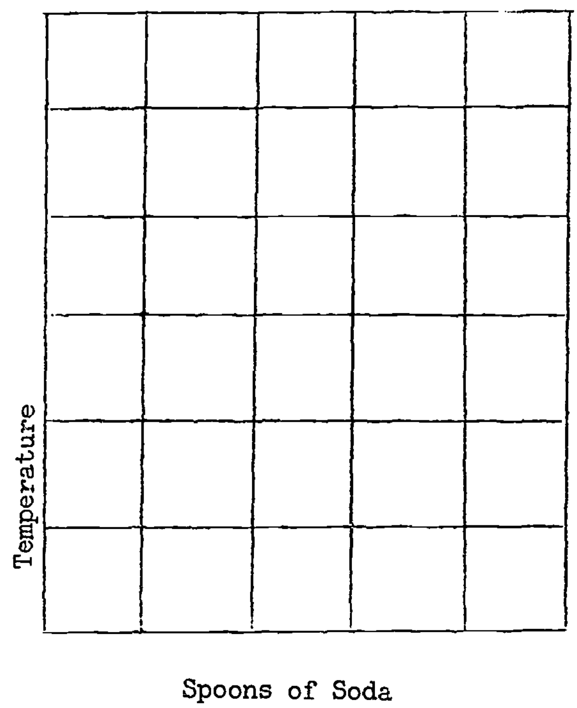
How much sulfur could you dissolve in the water?________________

If salt water is salty and sugar is sweet, is the same amount of salt and sugar dissolved in the water?

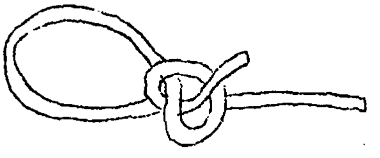
How do you know when the solution is saturated?

P-42

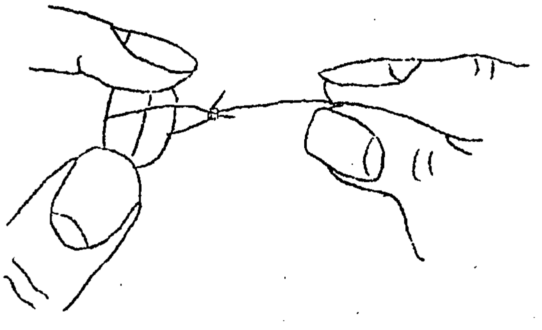
SODA Added (Spoons)	Temperature of Solution



P-45

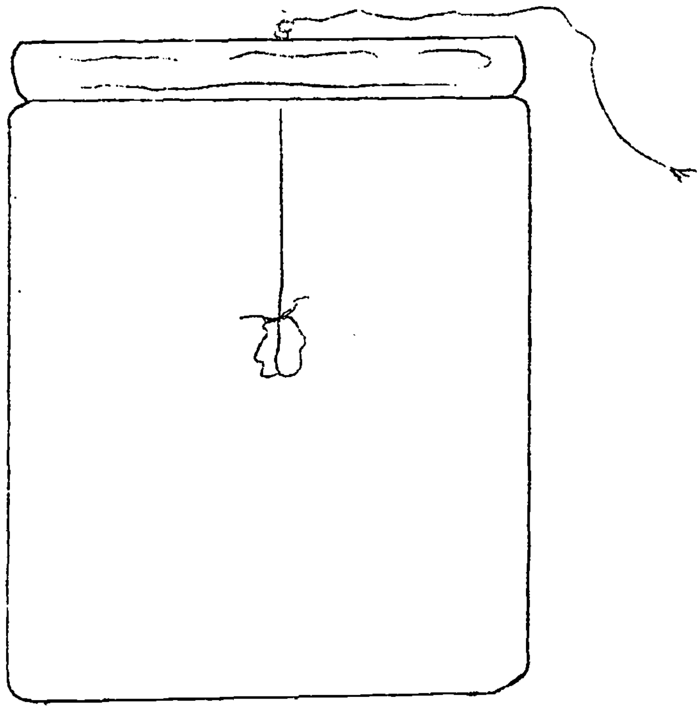


SLIP KNOT

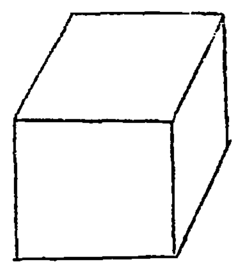


THREAD AND SEED

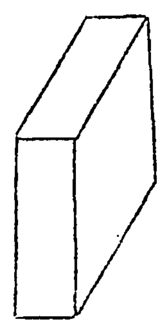
P-45



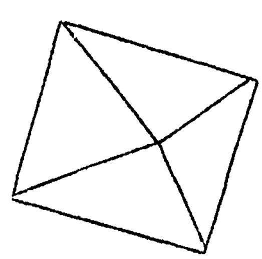
P-50



SALT CRYSTAL

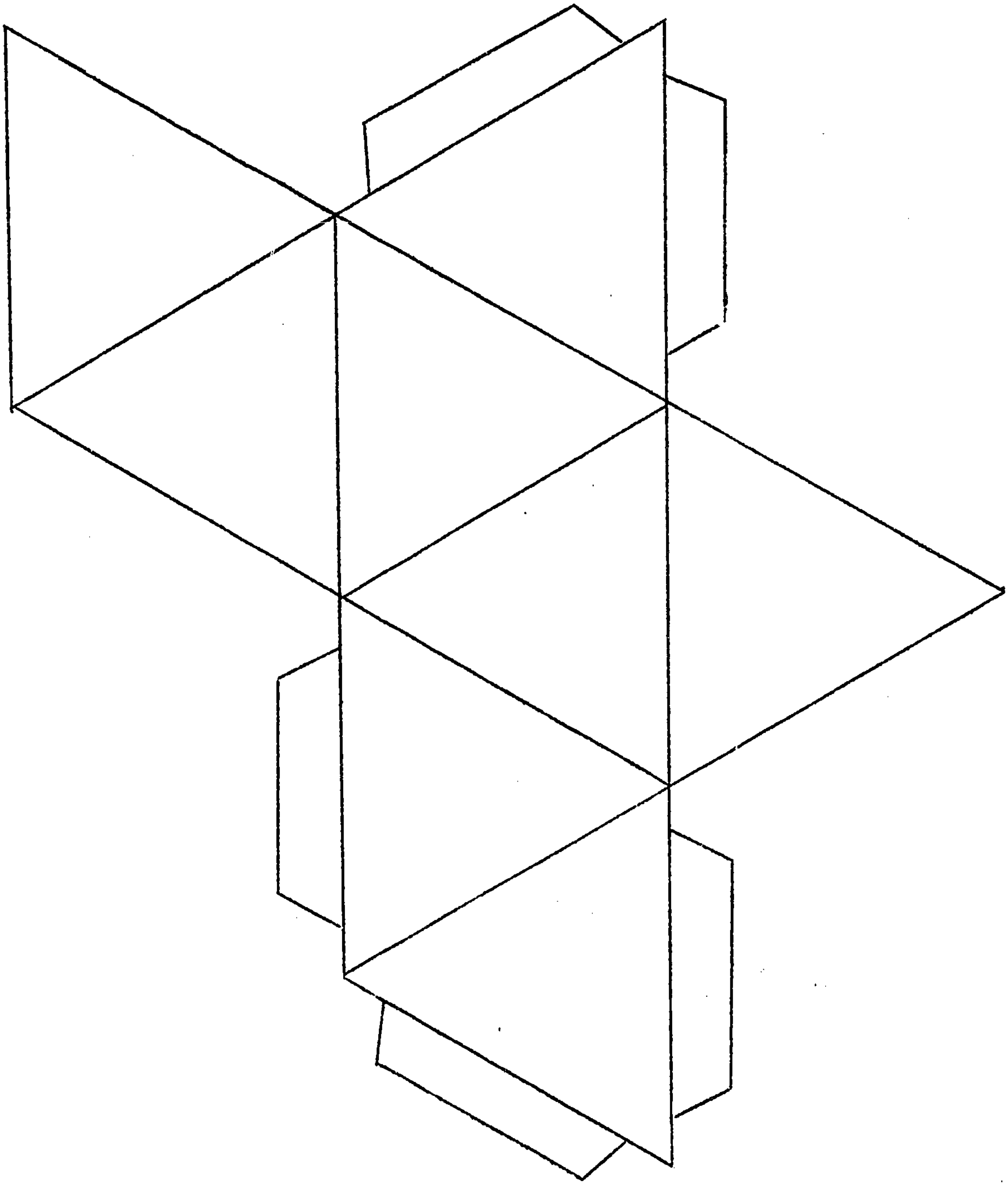


SUGAR CRYSTAL

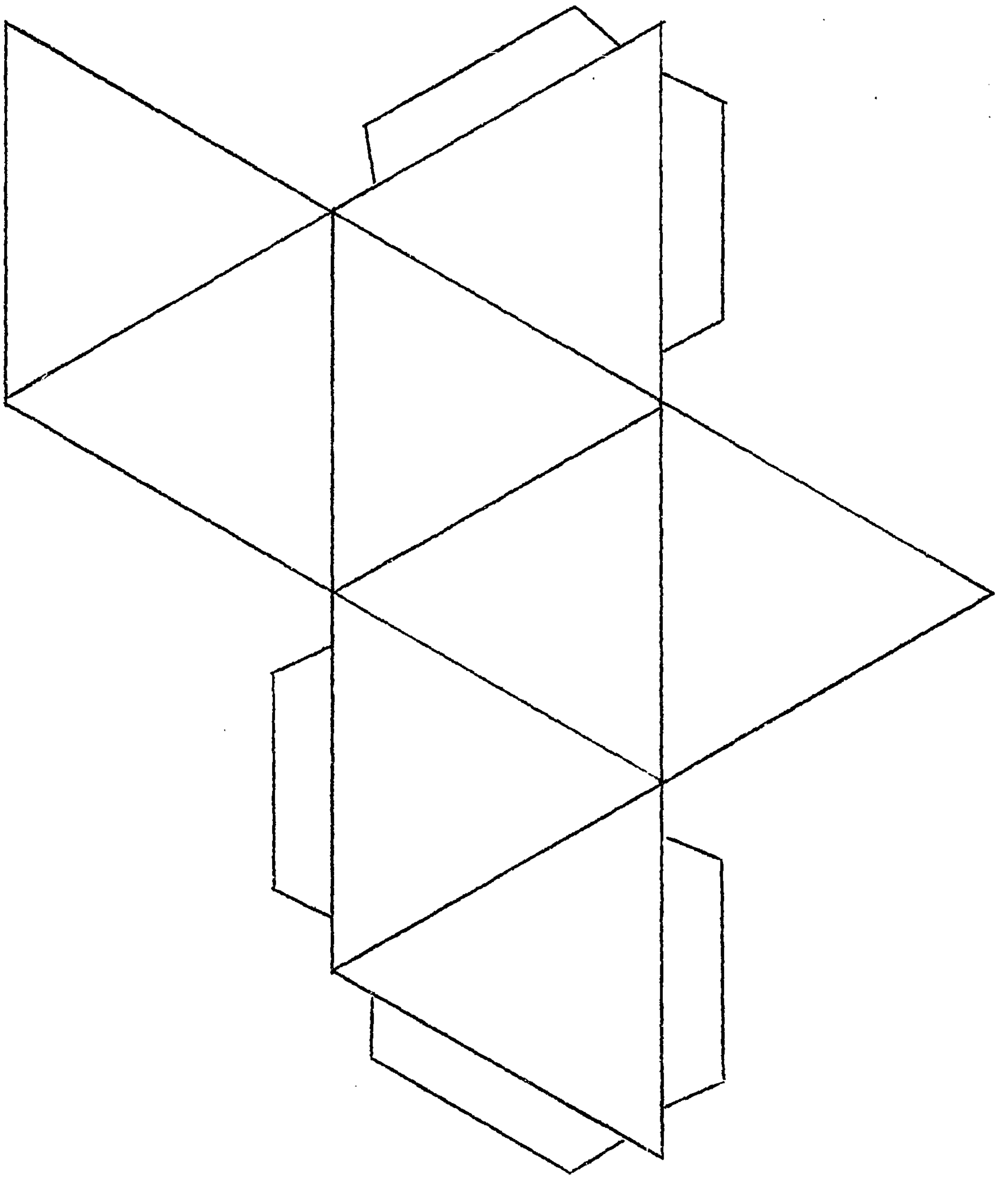


ALUM CRYSTAL

P-50

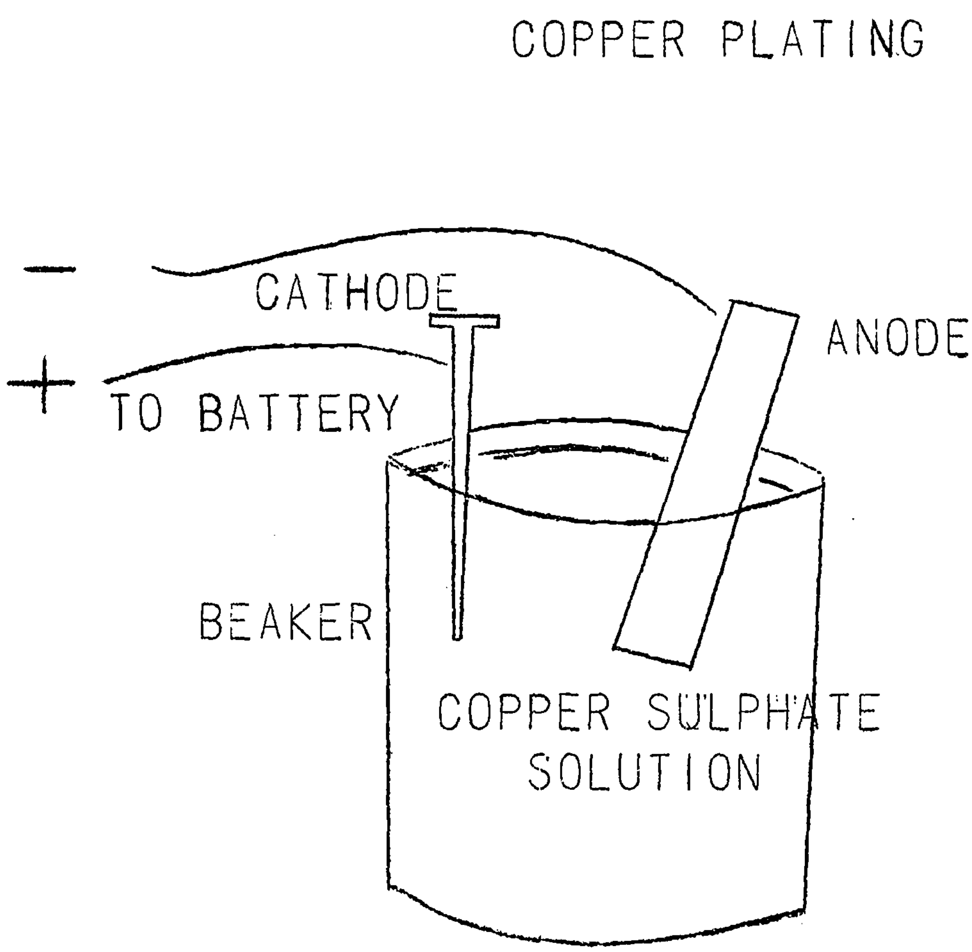


P-50



ALUM CRYSTAL

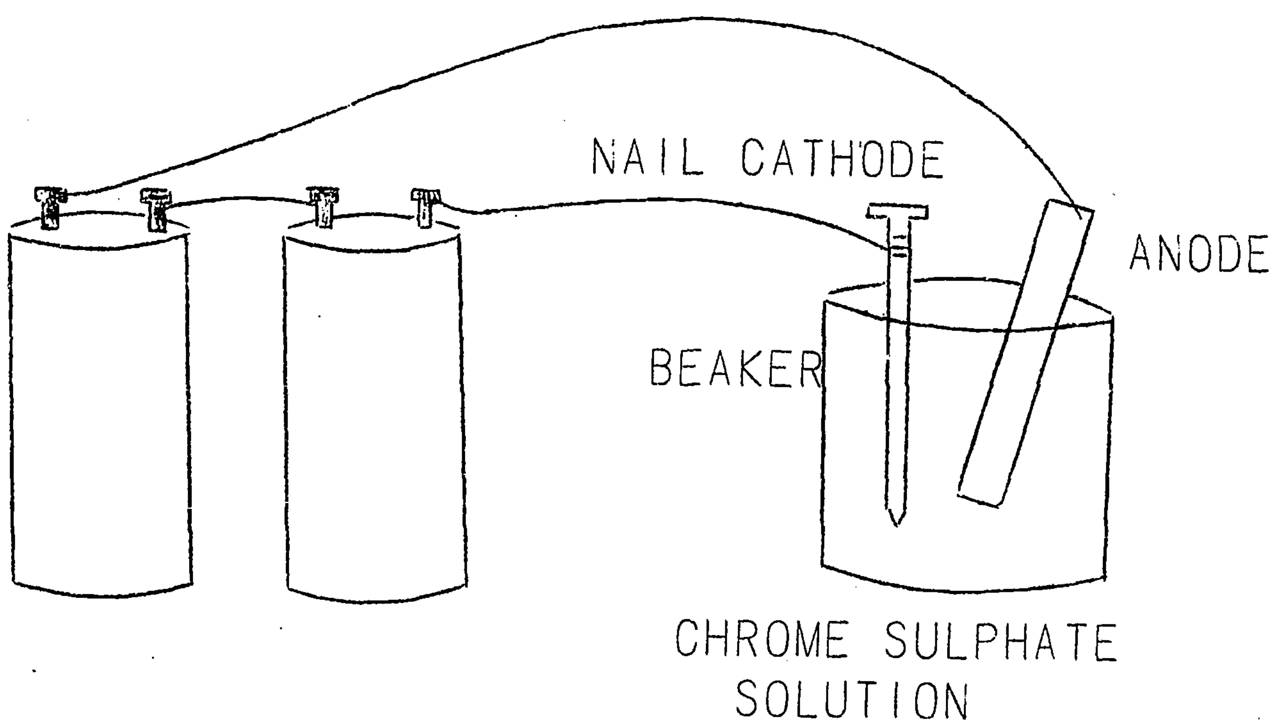
P. 51


COPPER PLATING
CATHODE
ANODE
TO BATTERY
BEAKER
COPPER SULPHATE
SOLUTION

MDP

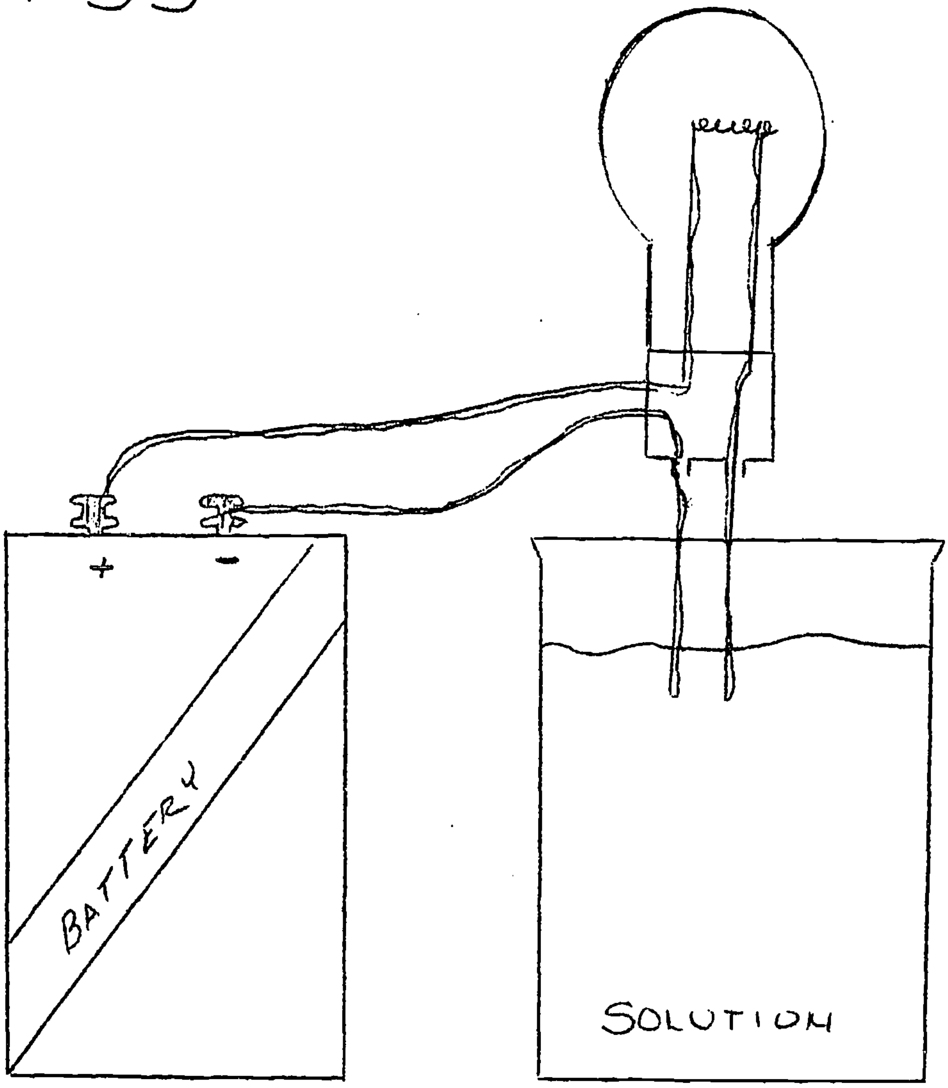
P52

CHROME PLATING

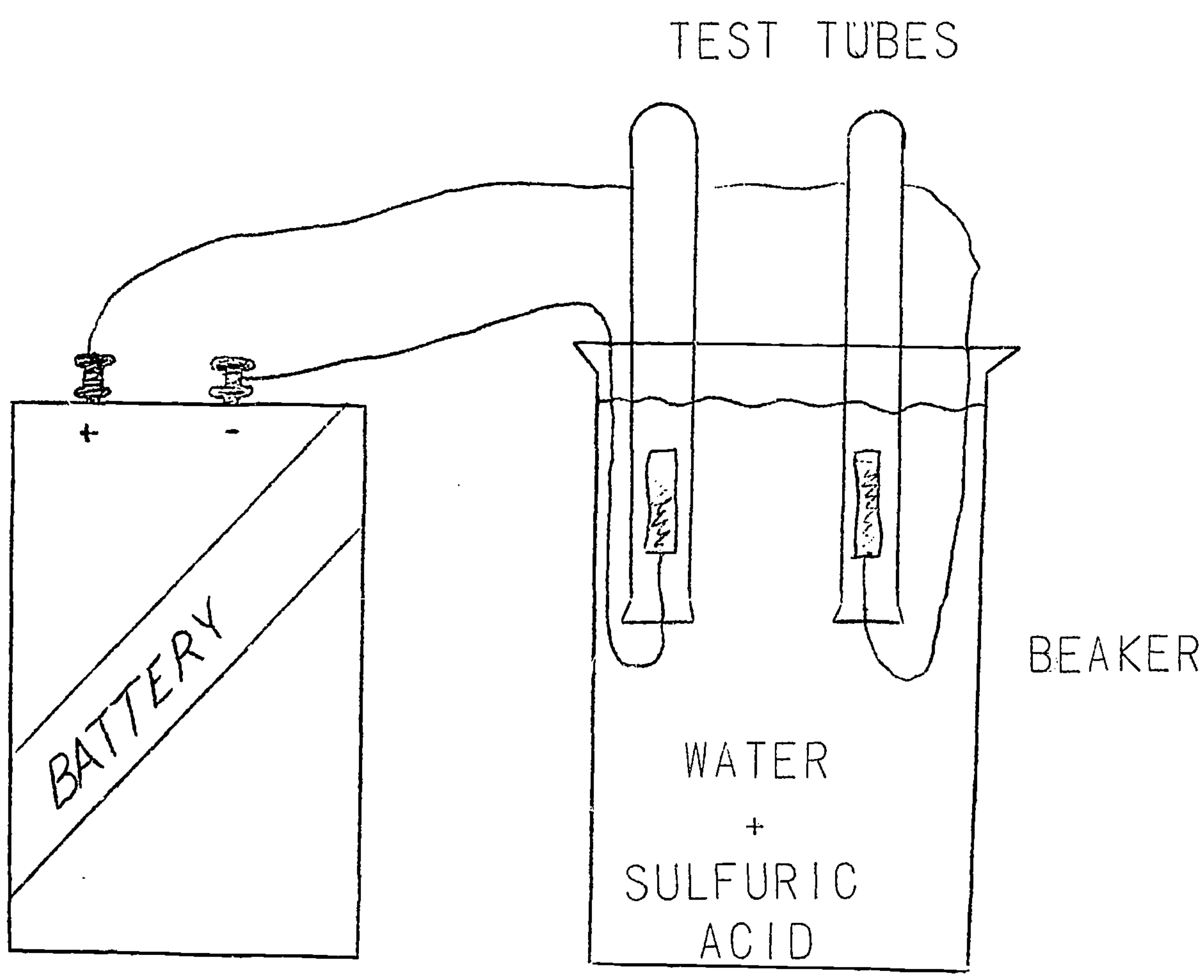


MDP

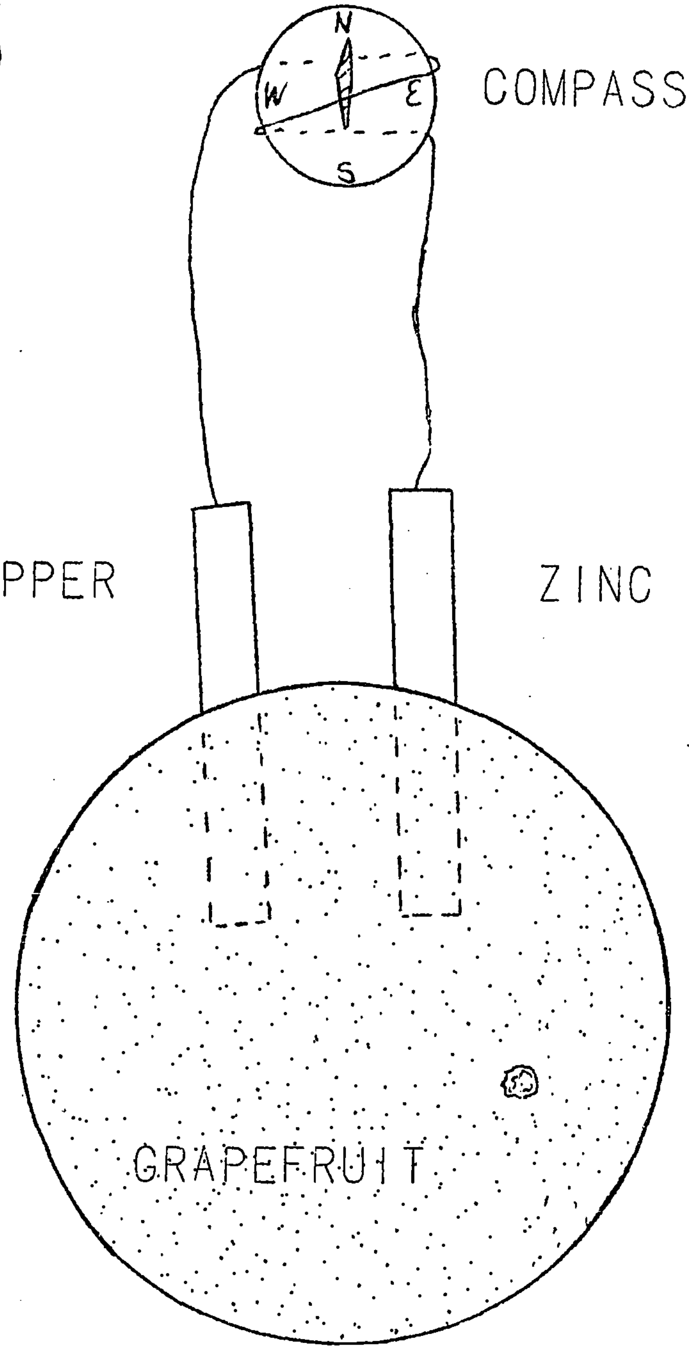
P53



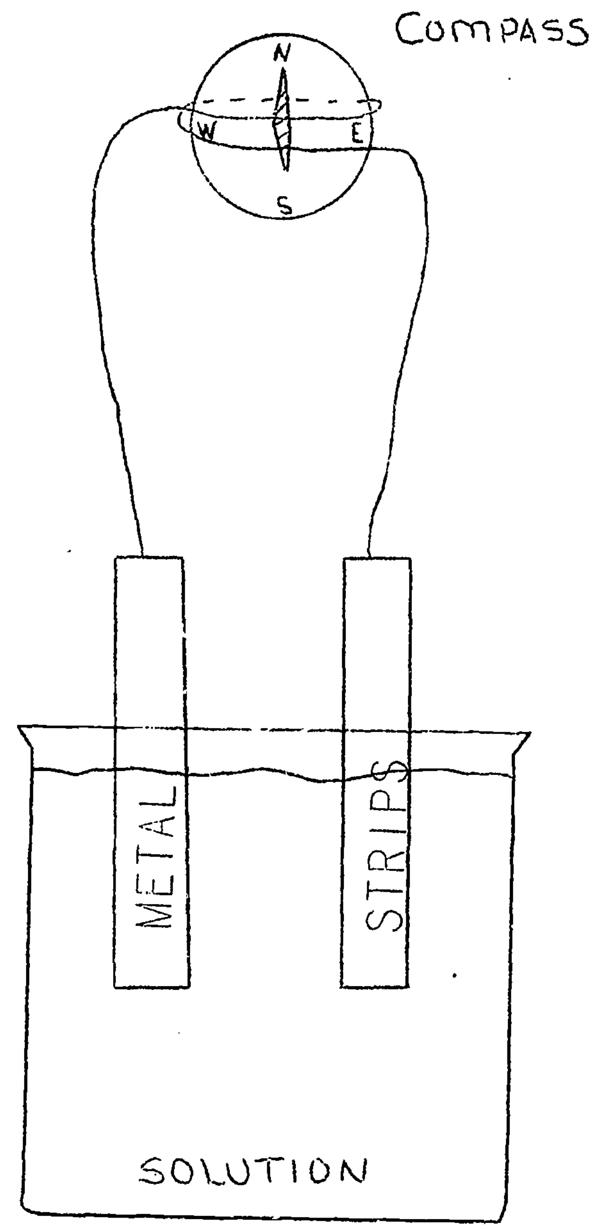
P-54



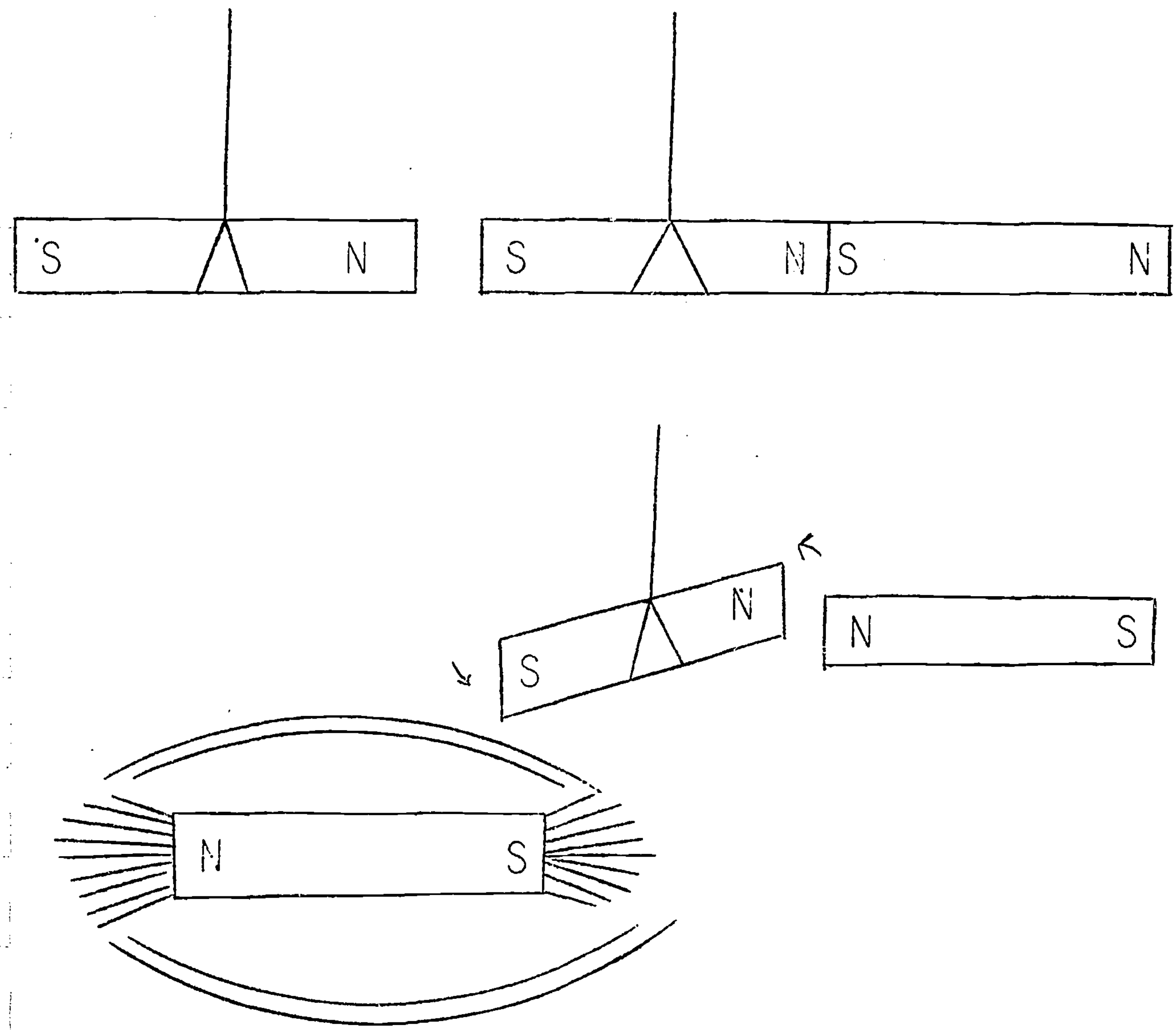
P-55



P 56

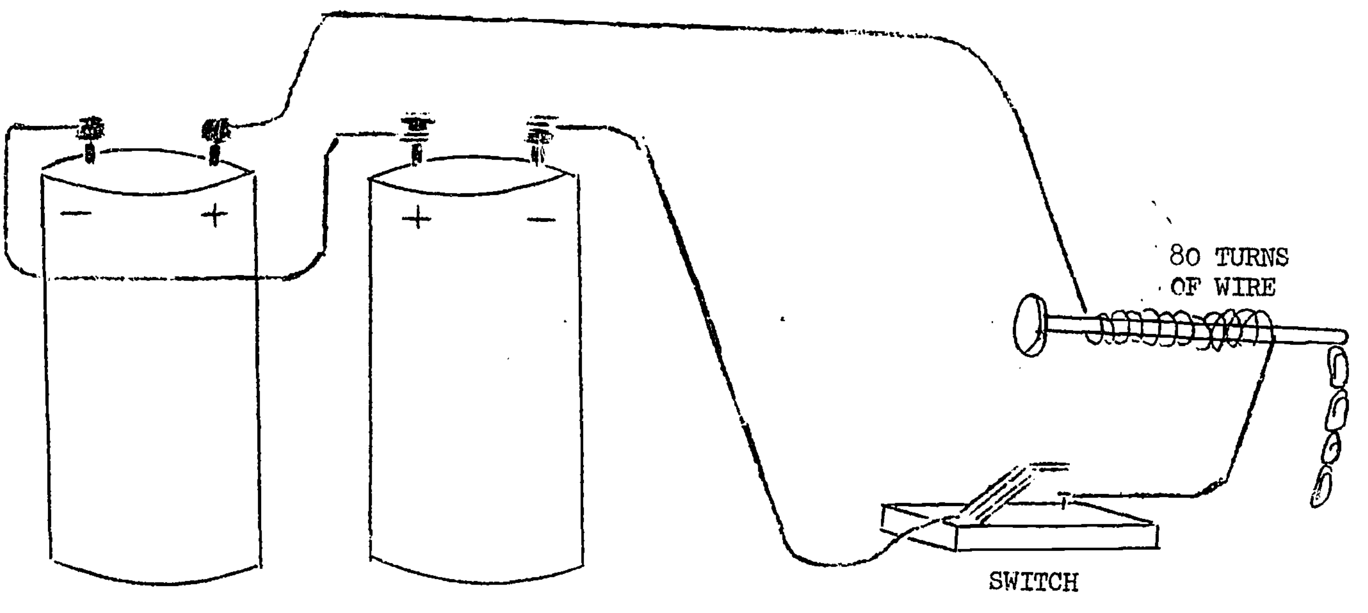


P-57

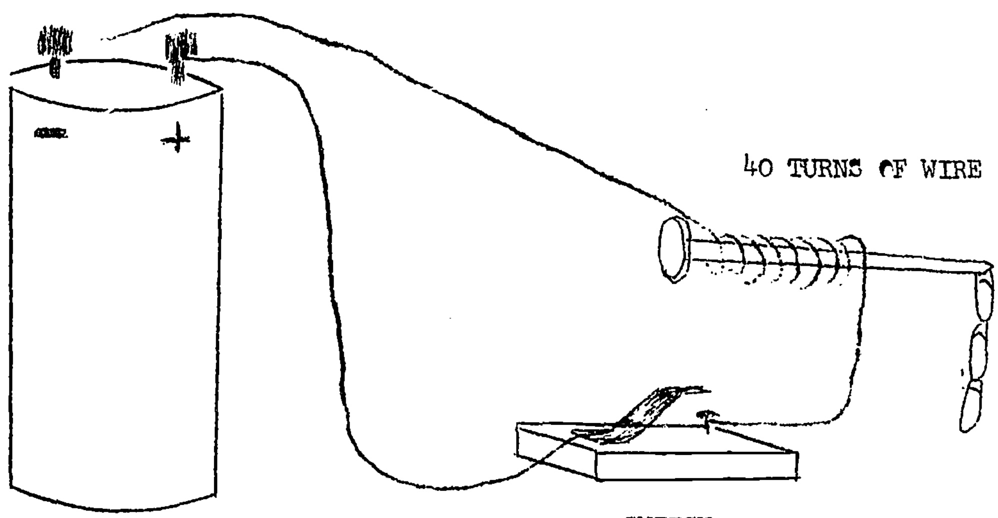


MDP

P-58

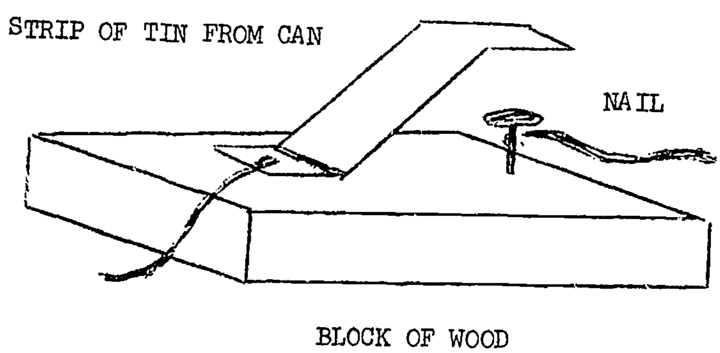


P-58



MDP

P-58



MDP